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BY- RANEY, JAMES W.
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A STUDY WAS MADE ON THE USE OF TELEVISION IN MEDICAL TEACHING AND RESEARCH THROUGH A SURVEY OF 88 MEDICAL SCHOOLS, SITE VISITS TO 22 OF THE SCHOOLS, AND AN ANALYSIS OF RECENT JOURNAL ARTICLES CONCERNING TELEVISION'S USE IN MEDICINE. THE SURVEY CONSISTED OF A DETAILED QUESTIONNAIRE WHICH WAS MAILED TO USER INSTITUTIONS. A TOTAL OF 47 SCHOOLS REPORTED TV INSTALLATIONS, WHEREAS, 41 SCHOOLS REPORTED NO USE OF TV. THERE WAS A LACK OF UNIVERSALITY IN THE USE OF TELEVISION. IT WAS DISCOVERED THAT 13 SCHOOLS USE THE MEDIUM IN ONLY ONE DEPARTMENT, AND 36 USE IT IN 5 OR FEWER DEPARTMENTS (AN AVERAGE NUMBER OF 17 DEPARTMENTS PER TV USER SCHOOLS WAS DETERMINED). IT WAS CONCLUDED THAT THE IMPRESSION OF WIDESPREAD AND VARIED USE OF TELEVISION AS A REGULAR, INTEGRAL TEACHING DEVICE IN MEDICAL EDUCATION IS NOT SUPPORTED BY THE FACTS. MANY OF THE REPORTED USES WERE FOUND TO HAVE BEEN ONLY ISOLATED EXPERIMENTAL APPLICATIONS OF THE MEDIUM. IN ADDITION TO THE SURVEY RESULTS, ABSTRACTS ARE INCLUDED WHICH COVER THE MOST IMPORTANT JOURNAL ARTICLES ON MEDICAL APPLICATIONS OF TELEVISION SINCE 1947. (JC)

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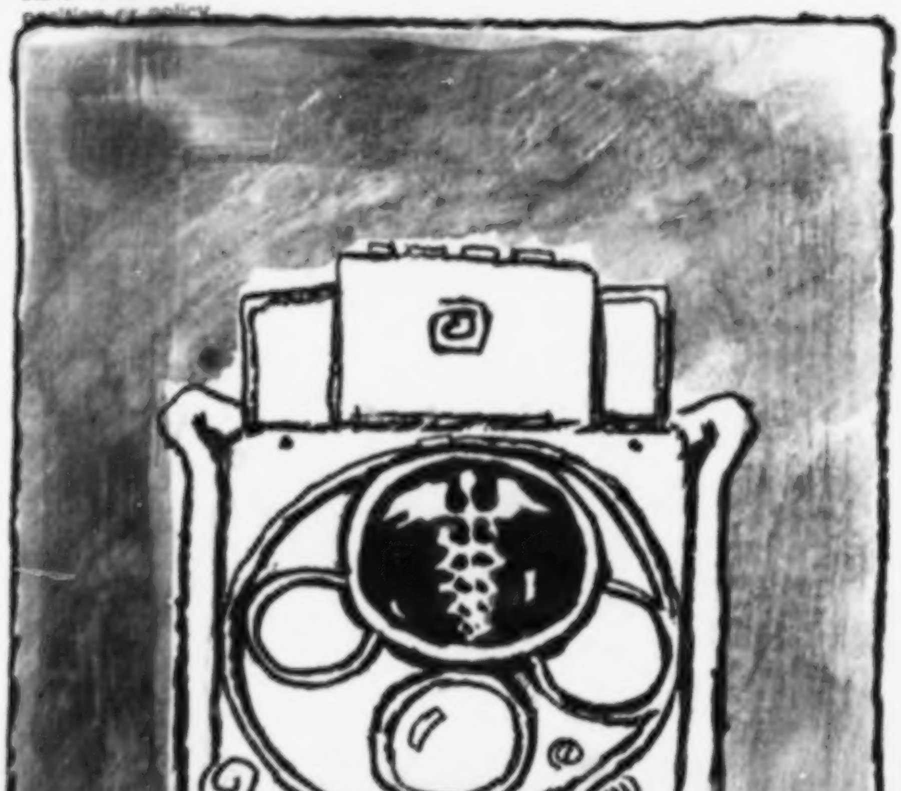

TELEVISION IN MEDICAL TEACHING AND RESEARCH

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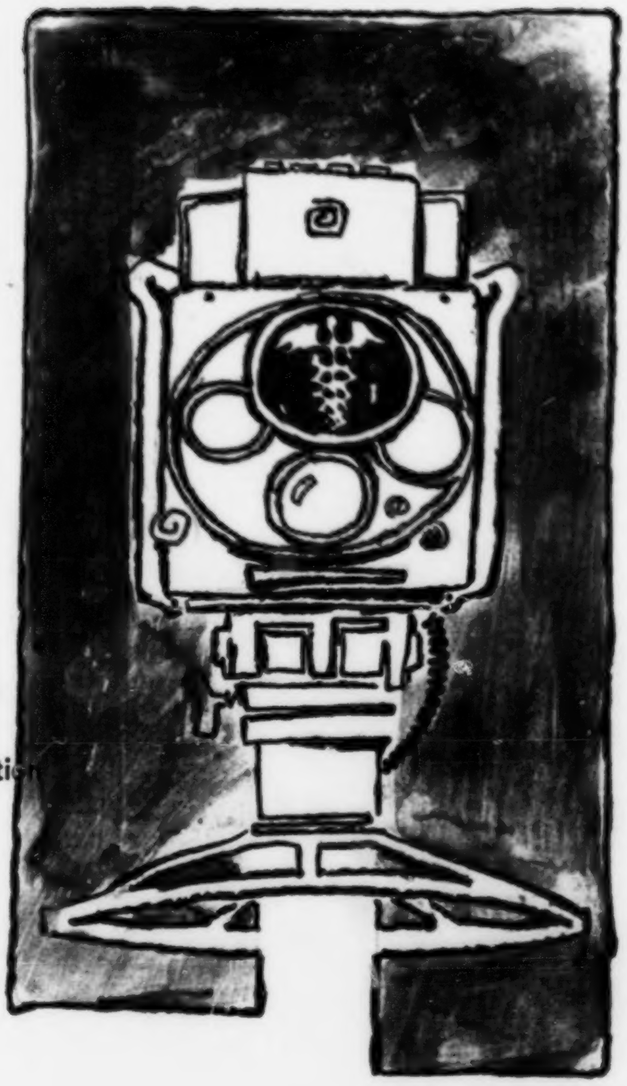
OE-34040

TELEVISION IN MEDICAL TEACHING AND RESEARCH

(a survey and annotated bibliography)



By
Dr. James W. Ramey
Council on Medical Television
The Institute for Advancement of Medical Communicati

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James W. Ramey

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INTRODUCTION

Interest in television as a teaching and research device for the medical profession dates from the 1920's, when Vladimir Zworykin and other television pioneers began perfecting this means of electronically extending human vision. In February 1947 the first closed-circuit telecast of a surgical operation at The Johns Hopkins University ushered in the age of medical television. Since that initial success, there have been steady advances in applications to particular needs, increasing ingenuity in adaptations of the medium, and growing acceptance and enthusiasm for this new tool. We have come to understand its limitations and potentials better with each passing year.

Television experimentation proceeded rapidly after Johns Hopkins showed the way. In 1949 the University of Kansas Medical School initiated television for teaching. Inter-city microwave telecasts were inaugurated that same year when The Johns Hopkins University transmitted an operation, live, from Baltimore to Washington, D.C. By 1951 a coast-to-coast color telecast of an hour-long program, including a question-and-answer session between New York and Los Angeles, demonstrated once again the potentialities of medical television.

Articles dealing with uses of the new medium became more frequent in the professional journals. Other medical schools began to consider installing television equipment, and here and there installations actually were made. In 1959, when 11 new installations were made, the number of institutions using the new tool was suddenly almost doubled. A conference on Television and Postgraduate Medical Education, held at the Clinical Center of the National Institutes of Health in February of that year, provided the catalyst for establishing a new organization to serve as a forum, clearinghouse, and agency for research and development in the use of television in the health sciences. This new group, the Council on Medical Television, was sponsored by the Institute for Advancement of Medical Communication. Conceived as a means of marshaling the resources and facilitating interaction among the many types of organizations interested in applying television to the health sciences, the Council soon concluded that one of the most pressing problems was lack of information about the state of the art.

The U. S. Office of Education provided support for a study of the use of television in medical and dental education and research under Title VII, Part B, of the National Defense Education Act. This report covers the medical section of that study.

In November 1961, a return-postcard mailing was made to the deans of the 88 medical schools in the United States identified in the Association of American Medical Colleges' Directory. Early in 1962, on the basis of the returns, a preliminary questionnaire was sent to the individual designated responsible for the use of television at each school that indicated any use of television. Based on the indicated complexity of the reported installations, site visits were scheduled to 22 of these schools, and were concluded by the fall of 1962.

When analysis of the material revealed that expected data had not been made available, an additional set of questionnaires was sent to some 30 of the schools reporting installations, supplemented by telephone calls to many others. It was finally concluded that the impression of widespread and varied use of television as a regular, integral teaching device in medical education (generated by the many journal articles that have appeared over the past decade) was not supported by the facts. Instead, many of these reports were found to have been about isolated experimental uses of television.

PART I--THE SURVEY

Quantitative Data on the Use of Television

The diffusion curve in technological innovation is much more accelerated today than in past decades. Whereas formerly, the point of near saturation was expected to come as long as 35 years after the introduction of an innovation, today it is expected to come in less than half that time. The use of television to teach medicine is no exception. Since the first installation at the University of Kansas in 1949, more than half the medical schools in the United States are now using television; three have tried it and given it up, four are planning installations, and nine have been experimenting with it.

Table 1.--Number of medical schools in the United States that use TV and do not use TV

	Schools		
Type of Control	Using TV	Not Using TV	Total
Total	47	41	88
Public	31	14	45
Private	16	27	43

The acceptance curve is accelerating, and a pattern may perhaps be emerging that relates more to the ability of each medical school to afford this teaching tool than to a basic questioning of its desirability. On the whole, publicly supported schools have spent more on television than privately supported schools.

Table 2.--Selected data on privately supported medical schools using TV

[NA=No answer]

Year TV Installed	School	Enrollment	No. of depts.	Depts. using TV	Total cost of Installation
	Total	6,292	291	56	$607,350
	Average	398	18	3.5	37,959
1953	Albany (Union Univ.)	240	15	13	$100,000
1955	Pittsburgh	369	19	4	3,850
1956	Baylor	338	18	2	35,000
1957	Columbia	475	22	1	9,000
1958	Georgetown	397	16	6	10,000
1958	Temple	523	22	4	30,000
1958	Western Reserve	324	13	5	7,000
1959	Jefferson	659	20	5	93,000
1959	Albert Einstein (Yeshiva U.)	364	19	5	55,000
1960	Boston University	285	19	3	4,500
1960	Duke	312	16	4	196,000
1961	Tufts	438	18	1	9,000
1961	Northwestern	525	19	1	18,000
1962	Cornell	335	13	1	11,000
1962	Marquette	393	25	NA	11,000
1962	Yale	315	17	1	15,000

Table 3.--Selected data on publicly supported medical schools using TV

[Code: NA=No answer; [1]=Uses ETV station or network for postgraduate programing; [2]=Estimated]

Year TV Installed	School	Enrollment	No. of depts.	Depts. using TV	Total cost of Installation
	Total	11,743	509	123	$1,296,378
1949	Kansas	385	16	10	$ 100,000
1953	Utah	203	16	2	2,500[1]
1954	North Carolina	266	13	3	12,000
1954	Louisiana State	437	16	2	11,000
1955	Nebraska	316	17	2	35,000
1955	Arkansas	331	12	5	2,500[2]
1956	Pennsylvania	508	20	1	58,500
1956	Univ. of Washington	293	15	7	23,000
1957	Univ. of Calif., Los Angeles	251	15	6	160,500[2]
1957	New York, Downstate	567	15	1	8,078
1958	Vermont	192	21	5	2,800
1958	Iowa, State U. of	434	20	3	18,000
1959	Med. College of Georgia	373	17	8	10,000
1959	Howard	387	12	2	3,500
1959	Maryland	367	18	4	3,000
1959	Michigan	724	20	18	300,000
1959	Mississippi	274	16	7	65,000
1959	New York, Upstate	393	16	5	30,000
1959	Ohio State	575	14	NA	75,000
1959	Alabama	300	17	2	20,000
1959	Wayne State	371	22	1	None [1]
1960	Minnesota	502	18	1	40,000
1960	Univ. of Calif., San Francisco	860	20	13	163,000
1961	Florida	190	13	3	6,500
1961	Texas (Galveston)	481	15	1	4,500
1961	Med. College of Virginia	318	23	4	20,000
1961	South Carolina	637	19	1	None [1]
1961	Wisconsin	341	20	2	43,000
1962	South Dakota	80	14	1	4,000
1962	Oklahoma	387	19	1	None [1]
NA	Texas (Houston)	NA	NA	2	75,000
Average for schools having installation cost		391	17	4	46,297

Table 4.--Size of enrollment in medical schools that do not use TV

School	Size of enrollment	School	Size of enrollment
Publicly supported (14)		Privately supported (27)	
Total	4,743	Total	8,998
Average	338	Average	333
Cincinnati	352	Bowman Gray, Wake Forest Coll. (N.C.)	210
Colorado	312	Buffalo	310
Illinois[1]	729	Chicago Medical School	259
Indiana	649	Univ. of Chicago[3]	295
Kentucky[2]	225	Creighton	287
Louisville	371	Dartmouth[1]	60
Missouri[2]	284	Emory	291
New Mexico	[4]None	George Washington[1]	379
North Dakota	80	Hahnemann[1]	384
Oregon[1]	300	Harvard	506
Tennessee[3]	567	Johns Hopkins[1]	344
Texas (Southwestern)[1]	420	Loma Linda[1]	390
Virginia	294	Mayo	642
West Virginia[2]	160	Meharry	254
		Miami	282
		New York Medical College	509
		New York University[3]	507
		Rochester[1]	290
		St. Louis	420
		Seton Hall	298
		Southern California	272
		Stanford	248
		Stritch, Loyola Univ. (Chicago)	325
		Tulane[2]	499
		Vanderbilt	205
		Washington University	334
		Woman's Medical College of Pa.	198

[1] Has experimented with TV.

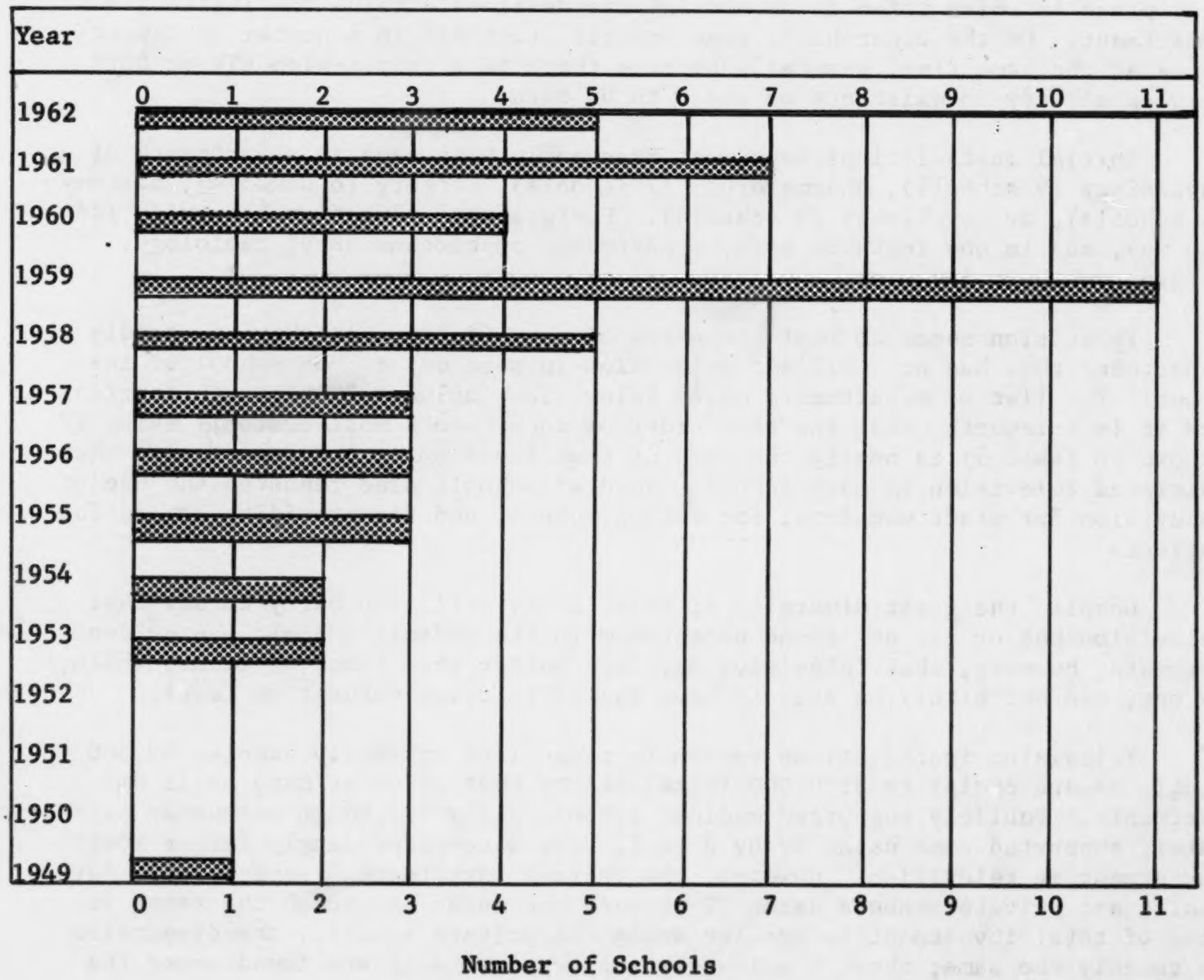
[2] Is planning to install TV.

[3] Is no longer using TV.

[4] The first students are to enter in Fall 1964.

After the Kansas installation in 1949, the next installations were made in 1953 by Albany (at Union University) and Utah, and the next after those, in 1954, by North Carolina and Louisiana State. Figure 1 shows the growth pattern for the period 1949-62.

Figure 1.--Number of schools making initial installation, by year: 1949-62



The fact that so many institutions have some kind of television installation cannot be taken as an indication of total commitment to the use of TV; rather, it is still regarded as being in the trial-and-error, or proving stage. Because this examination was undertaken at a time when 35 percent of the installations were less than 4 years old, 59 percent less than 5 years old, and 70 percent less than 6 years old, few conclusions can be drawn about the meaning of the data presented here.

The typical pattern would appear to be as follows: One department in a medical school makes a first, modest installation. Other departments adopt a wait-and-see attitude. If the new teaching device survives several years, cautious inquiries about possible extensions into other departments flower into actual experimentation and development. Sometimes separate installations are made or the initial installation is extended into a system that may embrace several departments, e.g., the entire basic science and/or clinical science area; sometimes, a television installation even becomes a school-wide enterprise. Some schools never get beyond the basic one-department phase or a similar phase in which token or ceremonial use develops outside the initiating department. On the other hand, some schools start off in a number of departments at the same time, generally because there is a campus-wide ETV or CCTV network already in existence or about to be born.

Initial installations have most frequently been made in departments of physiology (9 schools), pharmacology (7 schools), surgery (6 schools), anatomy (5 schools), or psychiatry (5 schools). Postgraduate education has twice led the way, and in one instance each, departments of biochemistry, radiology, ob/gyn, ophthalmology, or pathology.

Television seems to meet the needs of many fields, for there is hardly a department that has not utilized television in some way at one school or another. The list of departments using television includes 27 separate entries, and it is noteworthy that the rank order of departments most commonly using TV (shown in table 5) is nearly the same as that found among the departments that initiated television in each school. Several schools also reported the use of television for staff meetings, for making rounds, and for providing movies for patients.

Despite the great diversity of uses, it is still too early to say that television has or has not found acceptance in the medical school; the evidence suggests, however, that television may fare better than teaching-films, which, by now, can definitely be said to have failed to reach saturation level.

Television installations currently range from extremely simple, $2,500 single-camera chains to $300,000 installations that serve as many as 18 departments. Publicly supported medical schools using TV, which outnumber privately supported ones using TV by 2 to 1, have a correspondingly larger total investment in television. However, the average investment, respectively, for public and private schools using TV is much the same. Although the range in size of total investment is smaller among the private schools, the dispersion is roughly the same; thus, 4 privately supported schools are found among the 12 schools that have an investment in excess of $50,000.

Table 5.--Distribution of TV installations by department

Department	No. using TV
Physiology	22
Pharmacology	19
Psychiatry	18
Anatomy	14
Radiology	14
Surgery	12
Obstetrics/Gynecology	9
Pediatrics	7
Continuing Education	7
Cardiology	7
Pathology	6
Biochemistry	5
Anesthesiology	4
Nursing	4
Ophthalmology	4
Experimental	4
Neurology	3
Histology	3
Microbiology	3
Embryology	3
Comprehensive Medicine	2
Ear, Nose, Throat	2
Medical Electronics	2
Rehabilitation	2
Cancer	1
Dermatology	1
Hematology	1

It should not be assumed that the $1,296,378 capital outlay reported for 31 publicly supported schools represents public expenditures only. Although 11 schools did not answer questions about sources of capital funds, among the 36 which did, only 11 (less than a third) reported funding from budget only, and 1 from a special legislative appropriation only. Five of these 11 were publicly supported. The rest of the schools reported some combination of budgeted funds, grants, and/or special legislative appropriations. Another 11 schools from the sample as a whole reported gifts as their sole source of capital support, and 13 schools (29 percent of the 36 schools reporting) cited the budget-plus-gift and special appropriation combination.

The fact that 13 schools use television in only 1 department and 36 use it in 5 departments or fewer (an average of 4 departments per school for the entire sample) underscores the lack of universality in the use of television. Diffusion has been slow within individual schools, for there is an average of 17 departments per school among the 47 schools using television. (For a direct comparison, refer to tables 2 and 3, which list both the total number of departments per school and the number using television.) It is nevertheless a fact that the longer a school has used television, the more of its departments are likely to be using it.

Twenty-three percent of the reporting institutions use television only in the basic sciences, another twenty-three percent use it only in the clinical sciences, and 45 percent use it in both clinical and basic sciences. The indication is that, from the initiating department, television use crosses over from basic to clinical or vice versa (usually through clinical correlation courses) as often as to "sister" departments only. Four schools (9 percent) did not answer questions in this area.

There are several approaches to the question of how useful television is in medical teaching. Type and complexity of equipment, versatility, mobility, and cost of operation are a few of the measures of usefulness that lend themselves to quantification. We can, and do, assume that a dedicated, ingenious man may get a greater increase in teaching effectiveness from a simple camera chain costing $3,000 than a disinterested colleague operating a $75,000 full-color system.

Table 6.--Numbers of TV cameras owned by schools using TV

No. of cameras	No. of schools
Total	47
1	15
2	11
3	1
4	5
5	3
6	2
7	1
8	1
9	2
16	1
No response	5

A total of 136 television cameras was reported for 42 schools in this study. Of the 42 schools, 5 reported the use of color cameras. Four of those five were publicly supported, and one of them reported color equipment only. Of a reported total of 11 color cameras, 5 were reported by 1 school. Although the average installation includes slightly more than 3 cameras, 26 schools reported either 1 or 2 cameras, while 10 schools, each having 5 or more cameras, reported 76 of the 136 cameras reported for the entire study.

The distribution of monitors and receivers is similar to that of cameras. Again we find 17 of the schools having fewer than 5 units each, and 4 schools among themselves having 129 of the total 385 units reported. Twelve schools own 254 of the 385 monitor and receiver units. Monitors outnumber receivers 2 to 1.

Much of the equipment is mobile, and several schools have devised ingenious carts or carriers for it. These carrying devices range in complexity from the custom-designed mobile unit with cable reels, built-in monitor and camera brackets, microphones, and lights to supermarket shopping carts. Mobile origination is mentioned by 14 schools (30 percent), and 4 more noted that programing could originate from anywhere on the cable system. Thirteen schools reported mobile reception equipment, and 4 more reported reception equipment that can be plugged in anywhere on the transmission system. Table 7 indicates the numbers of schools having various origination and reception areas.

Table 7.--Areas of TV origination and reception

Areas of origination	Number	Areas of reception	Number
Total	95	Total	85
Laboratories	18	Classrooms	22
Mobile	14	Auditorium	15
Surgery	14	Mobile	13
Classrooms	9	Laboratories	12
Clinics	7	Any point on the system	4
Studio	6	Clinics	2
Psychiatric interview room	5	Delivery room	2
X-ray	5	Surgery	2
Any point on the system	4	Amphitheater	2
Demonstration rooms	3	Surgical staff room	2
Morgue	2	X-ray	2
Auditorium	2	Lounge	1
Patients' rooms	1	Student union	1
Dental school	1	Autopsy	1
Speech school	1	Patients' rooms	1
Wards	1	Wards	1
Labor room	1	Research	1
Delivery room	1	Gallery	1

More than 50 percent of the schools reported use of 2-way audio, 23 percent reported that they do not use 2-way audio, and another 23 percent failed to answer the question. Of the users, 56 percent reported that their experience with 2-way audio had been excellent; 12 percent, fair; and a few schools, poor. The rest did not rate their experience or did not answer the question.

Two schools have separate crew intercom circuits in addition to 2-way audio for student-teacher communication, two have physiological data systems that operate in conjunction with their audio-video systems, and one school reported 2-way video as well as 2-way audio. Patient-monitoring systems are in operation in seven schools, usually in the recovery room or in an intensive care unit, and in many cases these systems constitute part of the audio-video teaching system. Three other schools anticipate installing patient-monitoring systems.

Eleven schools reported the combined use of television with an image-intensifier system for radiology and/or cardiology. Some of these schools link the radiology department to classrooms and/or surgery to facilitate clinical correlation or radiological verification during surgery.

Slightly less than half the schools in the study (21) set up basic science demonstrations with students, demonstrator, and equipment all in the same room at least part of the time. With a single exception, they uniformly found this an asset. The lone dissenting school remarked that in the particular demonstration it had tried (cardiac catheterization), television added too much equipment to the already overcrowded room and became a definite drawback when students were also in the room. Some schools reported very negative effects from classroom interruptions occasioned by television; the value of the medium, they said, was almost lost if the class had to be broken up while the instructor went to a demonstration studio. This was true whether the students stayed where they were in order to view monitors or whether they also went to another room.

Nine medical schools reported that their university's School of General Studies also used television, and eight reported ETV stations on the campus. Ten of these 17 schools are using personnel or equipment related to one, the other, or both of these sources.

Little correlation exists between cost or complexity of an installation and the designation of specialists to handle it. An examination of the 12 most expensive and the 12 least expensive installations reveals that there are more people and departments charged with responsibility for TV among the schools with cheaper installations than among those with expensive ones. Of the 12 low-investment schools, 5 have AV directors, AV committees, and biomedical electronic engineers or departments; 1 has an AV director and an AV committee; 1 has an AV director and a biomedical electronic engineer; 3 have biomedical electronic engineers or departments; and only 2 have no such personnel or departments. On the other hand, among the 12 high-investment schools, 2 have an AV director, AV committee, and a biomedical electronics engineer or department; 2 have an AV director and a biomedical electronics engineer or department; 3 have an AV director only; 2 have a biomedical electronics engineer or department only; and 3 have none of these. For the entire sample, the use of such assistance is detailed in table 8.

Table 8.--Number of schools reporting various types of specialized personnel in charge of handling TV installations

/Code: A - Medical AV department with full-time director
B - AV committee
C - Biomedical electronics engineer and/or department/

Types, or combinations of types, of specialists	No. of schools
Total	47
A	6
B	1
C	9
A and B	1
A and C	7
B and C	3
A, B, and C	7
No response	13

What are the costs and numbers of personnel associated with the operation and maintenance of medical television facilities and equipment? For purposes of this project, "operating costs" were defined as those annual expenses involved in repair, maintenance, service contracts, technicians' salaries, materials of an expendable nature, and "other" (a catch-all category that could include anything from laying coaxial cable to remodeling a studio, but specifically excluding the purchase of capital equipment). First, a look at the cost figures.

Table 9.--Summary of annual operating costs

Cost interval	No. of schools
Total	47
No expense	7
Under $1,000	7
$1,000 - 4,999	4
$5,000 - 9,999	4
$10,000 - 19,999	2
$20,000 or more	3
Don't know	9
No response	11

Probably the most significant finding of table 9 is that 9 schools report costs as "unknown," a finding that seems to imply the practice of many different budgeting philosophies. Some schools returned detailed breakdowns showing costs for microscopes, television, chalk, EEG equipment, etc., whereas others simply reported one lump sum for capital equipment, another lump sum for expendable equipment, another for maintenance, and so on. At schools that maintain central studio facilities on the campus, there may be more motivation to allocate charges to specific schools. Since some schools do not break down charges even to the extent of budgeting professional and nonprofessional salaries separately and since some charge maintenance costs to a separate maintenance or building-and-grounds budget, the figures may be extremely difficult, if not impossible, for them to report.

In some cases, there may well be an intent to avoid pointing up the cost of using any single teaching aid. Possibly a portion of operating expense for television is covered in some schools by grants and research money, and for this reason no expense or a very small figure was reported. When the salary of one technician is spread over 8, or 10, or more projects, it is certainly difficult to pin down the exact charge for his services in one area.

There were not many reports of salaried technicians operating medical television equipment. Only 20 schools (43 percent) reported full-time technicians, and 10 of these listed only 1. Three schools reported 2 full-time technicians and 5 schools reported 2 to 4. One school reported 6 and one reported 10. One school reported a half-time technician. Thus we have 49½ salaried technicians reported for 21 schools. In view of the fact that five schools are using color and that several have elaborate studio facilities, surprisingly few technicians were reported.

Few mentions were made of student help in television equipment operation. One school noted having one official helper; one said that as many as wished could help; and one used, as equipment operators, graduate students who plan to teach. At one school six students were selected for this purpose and were paid for their work. One school indicated use of 16 student helpers, and the other 42 schools did not answer the question. Thus, only 5 schools are definitely known to be making use of this resource and training device, although it would seem both practical and desirable to familiarize interested students with this teaching and research aid.

Two schools reported the unusual practice of purchasing complete technical service on a per-use basis, the charge in one case being $30 and in the other, $50. This price included equipment setup and technical checkout, rehearsal, and actual operation of equipment during the teaching session. In one case, the service is supplied by the ETV station on the campus, and in the other, by a private contractor.

What is the measure of television use in the 47 schools reporting installations? Some of the institutions gave no answers to questions about departmental use. Generally speaking, the replies that were given fell into three groups:

1. Those which reported regular use of television;
2. Those which reported occasional use of television;
3. Those which specified the departments using television, but which provided no other information.

Table 10 lists departments using television at each school. A total of 179 departments are reported, and information about 141 of them was received.

An analysis of the uses to which television has been put by various departments (see table 11) suggests a high positive correlation between commonness of use and range of adaptations. Television provides several obvious communication advantages: it can provide the optimal viewpoint; it can magnify the image; it allows any number of people to see the same thing at the same time; and it enables people to observe from remote locations. The initial use of this new tool in medical teaching would be expected to center around these advantages. There are other, more sophisticated ways of using this tool, however, that are perhaps less obvious and are certainly more demanding of both skill and money. Yet some of these techniques, such as the interrelating of several factors of a problem on the screen while the problem is being explored, the transforming of information from one type of read-out to another, or the storing of images for later use or editing, may in the long run be even more meaningful for teaching because they provide information otherwise unavailable.

By far the most popular use of television reported was magnification of images. Of the 141 departments that provided information, 124 indicated that they were using the magnifying capabilities of the television chain. In gross anatomy, for example, specimens are enlarged to permit students to see the small details. When histology students are preparing slides under the microscope at the bench, the instructor may provide visual checkpoints by displaying a similar slide on the television monitor.

Table 10.--Listing of medical schools and their departmental use of TV

Schools	Department of--																										
	Anatomy	Anesthesiology	Biochemistry	Cancer	Cardiology	Comp. Medicine	Continuing Education	Dermatology	Ear, Nose, Throat	Embryology	Experimental	Hematology	Histology	Med. Electronics	Microbiology	Neurology	Nursing	Obstetrics/ Gynecology	Ophthalmology	Pathology	Pediatrics	Pharmacology	Physiology	Psychiatry	Radiology	Rehabilitation	Surgery
Medical College of Alabama					X																						X
Albany, Union University	X				X						X			X		X		X	X	X		X	X	X	X		X
Albert Einstein, Yeshiva University	X										X											X		X		X	
Arkansas	X																	X				X	X	X			
Baylor																							X			X	
Boston University	X				X																	X	X				
Univ. of California (LA)									X		X											X	X	X	X		
Univ. of California (SF)	X	X			X		X								X			X	X	X		X	X	X	X		X
Columbia																						X					
Cornell																						X					
Duke	X																			X			X		X		
Florida					X		X																		X		
Medical College of Georgia			X			X												X			X	X	X	X			X
Georgetown	X		X										X									X	X		X		
Howard University																						X	X				
Iowa State																						X		X			X
Jefferson	X									X			X											X	X		
Kansas	X				X		X										X	X				X	X	X	X		X
Louisiana State																							X	X			
Maryland	X									X			X					X									
Michigan	X	X	X		X			X	X	X		X				X	X	X	X		X	X	X	X	X		X
Minnesota																							X				
Mississippi		X									X						X				X	X	X	X			
Nebraska																	X							X			
New York, Downstate																							X				
New York, Upstate	X																X				X	X	X				
North Carolina																								X	X		X
Northwestern																											X
Oklahoma																					X						
Pennsylvania																											X
Pittsburgh							X														X	X	X				
South Carolina							X																				
South Dakota	X																										
Temple	X					X																	X		X		
Texas (Galveston)																							X				
Texas (Houston)														X												X	
Tufts			X																								
Utah							X																				X
University of Washington		X													X		X			X	X			X	X		
Wayne State																							X				
Western Reserve							X											X	X	X				X			
Wisconsin					X																			X			X
Vermont			X							X												X	X		X		
Medical College of Virginia	X																					X	X	X			
Yale																									X		

Note. Ohio State and Marquette provided no data on departmental use of TV.

Table 11.--Number of departments using television for specific purposes

Department	Specific use						
	To magnify	To multiply	To optimize	To transport	To relate	To transform	To store
Total	124	107	100	93	49	31	18
Anatomy	13	12	13	7	6	1	1
Anesthesiology	3	2	1	2	-	-	1
Biochemistry	5	3	1	3	1	1	-
Cancer	-	-	-	-	-	-	-
Cardiology	6	3	5	3	1	5	1
Comprehensive medicine	1	1	-	1	1	-	1
Continuing education	6	6	5	6	4	1	1
Dermatology	1	1	-	1	-	-	-
Ear, nose, throat	1	1	1	1	-	-	-
Embryology	1	1	1	1	-	-	-
Experimental	2	2	4	2	-	2	-
Hematology	1	1	-	1	-	-	-
Histology	2	2	1	2	1	-	-
Medical electronics	2	2	-	2	-	-	-
Microbiology	2	1	2	2	-	-	1
Neurology	1	1	-	1	-	-	-
Nursing	3	3	-	3	1	-	1
Ob/Gyn	4	5	2	4	3	-	-
Ophthalmology	2	2	2	2	-	-	-
Pathology	6	5	2	2	-	3	-
Pediatrics	4	5	3	2	1	-	1
Pharmacology	18	14	16	8	9	3	1
Physiology	17	16	18	11	10	4	2
Psychiatry	8	8	11	14	5	-	4
Radiology	5	3	9	4	3	9	2
Rehabilitation	-	-	-	-	-	-	-
Surgery	10	7	3	8	3	2	1

Note. The data are not complete for all departments at all schools using TV.

The second most commonly reported use of television (107 departments) was image multiplication. This capability can, for example, provide an entire class with exposure to the same stimulus in an exam, thus eliminating the variation introduced by the passage of time and the small differences in presentation that necessarily occur in a walk-around test.

The use of television to optimize the viewpoint was the third most frequently mentioned adaptation. The 100 instances reported ranged from duplication of the surgeon's point of view during a tracheotomy to the use of several cameras to provide students with multiple viewpoints during a classroom demonstration.

The fourth-ranking use of the medium, reported by 93 departments, was to transport the image. In microbiology, for instance, television was used in isolation to show how polio virus was injected into a rat; during a psychiatric interview, it provided students both visual and aural communication so they could discuss the techniques used with their instructor, in a remote location, without disturbing the doctor-patient relationship.

The incidence of the remaining three (more sophisticated and expensive) uses of TV was significantly less. Forty-nine departments reported that they used television to relate various components of a demonstration or problem. For example, during surgery the simultaneous presentation of EEG and fluoroscopic images facilitates understanding on the part of the student. In psychiatry, simultaneous presentation of a long-shot of a patient taking a Rorschach test and a closeup of his facial expression superimposed on the Rorschach card being considered was effective.

Only 31 instances were mentioned where television was used to transform an image. In 14 of these, related to radiology or cardiography, television was used in conjunction with the image-intensifier, as in cardiac catheterization, monitoring peristaltic phenomena, or diagnosing pediatric abnormalities. Some departments are employing fiber optics and stereofluoroscopy and are experimenting with image addition and subtraction to extend the transformation possibilities of TV as a diagnostic, teaching, and clinical tool. Other transformation uses include ultraviolet visual inspection of living cells in depth perspective by means of 3-channel, simultaneous, superimposed viewing through black-and-white video tubes in a color camera (a 3-dimensional picture results when the tubes are selected to respond to different wavelengths), line-by-line television scanning, spotting tumors, and counting cancer cells.

Only 18 departments reported the use of television to record and store information. In view of the current price of videotape recorders, this is not surprising. Among those schools that do have access to recorders, however, uses cover a wide range: simple storage of an unusual or complicated, filmed demonstration; the recording and playing back of family interviews (in psychiatry); or the recording of student demonstrations, followed by insertion into the tape of analytic comments by a professor or review committee -- the student later reruns the tape.

In conclusion, the rush to television in medical teaching may be more apparent than real. Although more than half the medical schools in the country have joined the ranks of the "haves" in little more than a decade, only 179 of the total 1,500 departments in the Nation actually use television and only 141 of them use it fairly regularly or routinely. These 141 departments represent fewer than 1 in 10 nationally, so that the saturation point for television as a medical teaching tool appears still distant. But, if there is no rush to television, there is a steady increase in the number of converts. Although physiology, anatomy, pharmacology, psychiatry, and radiology departments seem to be leading the way, there is no clear reason why television should be of greater value in any of these areas than in biochemistry or anesthesiology, for example. And indeed, in some situations, these departments have led the way. Perhaps the crux of the matter is this: that the success of television in medical teaching depends less on the type of equipment or the amount of capital expenditure than on who is responsible for its operation and who introduced it in the first place.

Television may prove to be a turning point in American medical education. A teaching tool with so many advantages cannot be ignored, and once a department accepts the financial responsibility, its personnel are faced with the ethical and educational responsibility of rethinking the entire curriculum. For, in spite of P. W. Schafer's declaration in the early TV years at Kansas that television should not be allowed to change the instructor's teaching habits, any group of educators suddenly confronted with the ability to control time, space, perspective, distance, size, and perception would have difficulty ignoring these advantages. The steadily growing list of already documented, ingenious adaptations of television to medical teaching attests to the vigor of this new medium.

General Reactions to the Use of Television

This section of the report is comprised of a series of questions and synthesized answers intended to reveal the basic reactions to installing television. Not all the schools in the study provided substantive answers to these questions; in fact, no single institution was able to supply sufficient material to answer all the questions and there were some that answered only a few. The schools that are represented at least once include the following:

University of Alabama
Albany Medical College (Union Univ.)
Albert Einstein Medical College (Yeshiva Univ.)
Baylor University
Boston University
University of California (San Francisco)
University of California (Los Angeles)
Columbia University
Duke University
University of Florida
Georgetown University
Howard University
Jefferson Medical College
University of Kansas
Marquette University
Medical College of Georgia
Medical College of Virginia
University of Michigan
University of Mississippi
University of Nebraska
New York Downstate Medical Center
New York Upstate Medical Center
University of North Carolina
Northwestern University
Ohio State University
University of Oklahoma
University of Pennsylvania
University of Pittsburgh
Temple University
Tufts University
University of Utah
University of Vermont
Western Reserve University

University of South Carolina   Yale University
University of Wisconsin

Q. How did you happen to start using television and who was primarily responsible for initiating the steps that led to your installation?

The initial impetus for using television arose most frequently out of a need to stretch staff time, to get better image magnification, or to enable more people to see demonstrations. In a few cases the dean or a professor started the action that led to an installation, but in most cases a department chairman did.

Q. What was the initial objective of your installation?

Most installations were made in order to facilitate laboratory teaching, monitor various procedures, magnify images, improve observation and discussion facilities, or increase the size of groups simultaneously watching a demonstration.

Q. What was the extent of research and preplanning prior to buying equipment?

Preplanning ranged from sending representatives to visit and evaluate existing installations, through calling on industry representatives, to no planning at all. Some schools spent several years in faculty discussion and planning. Some borrowed equipment for experimentation, using it for a single demonstration or for a year or longer.

Q. Who was responsible for final approval of specifications?

In most cases, final approval was given by the dean or the department chairman, but in at least one instance each, the business manager, budget committee, or faculty was the final authority.

Q. What was the faculty attitude toward TV before it was installed?

Generally speaking, faculty members were either neutral or negatively inclined, except for individuals who had had previous successful personal contact with the medium.

Q. What was the faculty attitude toward TV after it was installed?

The innovating department was usually favorably disposed, whereas other departments often remained unenthusiastic. Since the use of television imposes the need for additional preparation and thoughtful reevaluation of content and methodology, many staff members did not wish to use television in teaching, even though they conceded its effectiveness. Reactions were not uniform.

Q. What was the student attitude toward TV before it was installed?

A number of chronic problems of students were partially solved through the use of television; for example, before installation, students frequently could not see or hear easily during demonstrations, felt time was wasted in waiting for instructors to come to the bench to answer lab-problem questions, and had difficulty relating some problems to live patients.

Q. What was the student attitude toward TV after it was installed?

The key point seemed to be the new-found ability to see what the demonstrator was talking about, increased ability to relate theory to practice, and the immediacy that television afforded, in contrast to films. Students were impressed by those instructors who used television well. There were increased attendance and attention, but some students indicated that 30 minutes exposure to television was the limit at one time.

Q. Did television ever exceed your expectations or make possible unanticipated pedagogical techniques?

Television seemed to prove unexpectedly valuable in correlating clinical and preclinical teaching, and there was some surprise that color proved unnecessary for most applications. The television image-intensifier made possible daylight fluoroscopy and good film recording for projection to students, thus eliminating the need to subject patients and students to unnecessary radiation.

Q. In what ways did television fail to fulfill your original hopes?

Although some schools emphasized that television in no way failed to live up to original hopes, the level of expectation had to be a deciding factor in answering this question. Unsatisfactory results with certain microscopic applications; the need for color in certain applications, usually surgery, anatomy and pathology; the sheer complication of using television in routine applications; and inadequacies of staffing, instrumentation, or physical facilities in some schools were among the disappointments mentioned.

Q. Has television facilitated more efficient use of student-faculty time?

Time has generally been used more efficiently, resulting in enrichment of the program rather than in a smaller staff in most instances. Both quality and quantity increased (as measured by material covered and by improved grades), but with the important qualification that for certain situations more time for preparation was needed. Most often cited was the reduction in repetitive demonstrations; the ability to do more sophisticated demonstrations; and the possibilities of discussing televised doctor-patient situations, asking questions of the doctor during treatment without disturbing the patient, and of greatly increasing clinical/preclinical correlation.

Q. Has television had any impact on curriculum organization?

Three important broad changes were noted: shift in emphasis from obtaining results to understanding and interpreting them; clearer, quicker clinical correlation; and generally more sophisticated demonstrations, made possible by the time saved through the use of television.

Q. Has television facilitated interdepartmental teaching?

Through use of television in clinical correlation, the traditional walls between clinical and preclinical departments are beginning to crumble.

Q. Has television produced any demonstrable financial savings?

It is too early to judge.

Q. Have you used television for tests or formal examinations?

Seven schools are now using or planning to use television for testing. One school felt that television would be extremely inappropriate for this use. Television tests have included objective multiple-choice, substitutes for walk-around tests, essay questions on cadaver dissections, and tests involving microscopic identification. Plans are underway to use 2-way audio-video for psychiatric testing. In two situations television-testing has been coupled with an electronic feedback network that permits the instructor to check student learning as he proceeds with his lecture or demonstration.

Q. Do you have any liaison with, or use of, television facilities and personnel connected with the university's school of general studies?

The few schools that answered this question indicated a general sharing of equipment with general studies departments.

Q. Did the initial installation stimulate other departments or other schools of the university to use television?

There were only 13 responses to this question, 4 negative, and most pointing up the slowness of diffusion after an innovating department takes the first step. Only 1 of these schools made its initial installation as late as 1960, and 8 of the 14 oldest installations were among the 13 respondents. More than half the schools using television reported that other departments were "thinking about using television."

Q. Do you now record any of your live TV presentations, or do you plan to?

Four schools were recording material and nine planned to do so. Some of the latter already owned tape facilities but were not yet using them. Tape is being used in anatomy, psychiatry, radiology, physiology, pharmacology, surgery, pediatrics, continuing education, cardiology, anesthesiology, nursing, microbiology, and comprehensive medicine. Tape is being used not only to record and store demonstrations, but also to record interviews with families of disturbed children for replay for the family, to prepare kinescopes for distribution to foreign and domestic medical schools, for studies in speech pathology, for fluoroscopy, and to provide students with an audiovisual playback of their work, replete with comments of their instructors dubbed onto the tape.

Q. What advantages or disadvantages do you find in 2-way audio for feedback or questions?

Two-way audio was found especially advantageous in situations where the class is remotely situated from the instructor or where the instructor and class together are remotely viewing a doctor treating a patient. The interaction is valuable in these and many other situations, as is the ability to monitor equipment performance. A number of respondents, however, felt that 2-way audio led to control by the remote viewer, a feeling shared by some lecturers and students during student interviews with patients.

Q. Do you feel that monochrome TV is adequate for your instructional uses?

Most schools feel that black-and-white is more than adequate for existing uses, but that color might be useful in surgery, pathology, and anatomy, especially for fresh tissue and microscopic slides.

Q. Is your school considering the use of open-circuit TV for postgraduate instruction?

Experimentation is already progressing in this coming field, and so far nine schools have done at least some programing. Some schools raised the objection that anything on open-circuit TV would not really constitute postgraduate education, and in some instances the postgraduate staff seemed little interested in television.

Q. Do you think scrambled-image transmission would facilitate postgraduate TV?

Surprisingly little action has been taken toward development of scrambled-image broadcasting, considering the concern expressed about iatrogenic disease. Only two answers to this question were recorded. One respondent thought there were instances where visual presentations might tend to be offensive or harmful to a lay audience; the other developed an encoder-decoder system in 1958 for postgraduate open-circuit broadcasting but did not put it into use. Significantly, the only experimental use of scrambled-image telecasting was quickly abandoned for regular open-circuit broadcasting.

Q. Do you use television instrumentation in research and/or diagnosis?

TV instrumentation is used mostly in radiology, perhaps because of the hazards of radiation and the tremendous possibilities for TV adaptations in this area. Other departments that use television for research include nursing, pharmacology, ob/gyn, microbiology, ophthalmology, and psychiatry. TV is also being used for diagnosis in pediatric abnormalities, neurological disorders, speech malfunctions, and psychiatric interviews.

Q. To what extent did you alter facilities in order to accommodate TV?

Alterations generally encompassed laying coaxial cable and setting up studio space. More specifically, psychiatric facilities frequently required interview areas that could accommodate hidden microphones and cameras; surgical installations often required remote-controlled equipment, special lighting, and special camera booms or brackets; and classroom and auditorium installations usually needed concealed conduit, controlled lighting, and air-conditioning.

Q. What mechanical and/or electrical modifications have you made to facilitate the use of television equipment?

Most schools have simply accepted whatever was available from the manufacturers and have added mobile carts to hold the equipment, stringing cables through halls, air ducts, and the like. Additional wiring has often been required. Special mounting brackets, teaching stations, and monitor stands have frequently been built by the maintenance department to accommodate equipment. Audio-feedback light panels and relay cabinets were frequently constructed, and some schools even built special light fixtures, kinescopes, and microscopic setups.

Q. What experiences have you had with TV equipment salesmen?

Reactions have not been consistent, either with regard to particular companies or to equipment salesmen in general. Some complained of inadequate information from salesmen, unwillingness to provide dynamic demonstration against competitive products, and uninformative catalogs; some felt they would rather talk to a manufacturer's chief engineer than to his salesman. Others said that manufacturers gave them excellent cooperation, and equipment loans from them for evaluation were common.

Q. What steps could manufacturers take to promote closer liaison with the health-science professions?

It was suggested that manufacturers might develop more equipment, send engineers to schools for consultation and closer liaison, encourage industrial attendance at health-science meetings, and mass-produce equipment and improve the quality so that costs could be brought down.

Q. What physical and instrumentation changes would maximize the value of television for medical education and research?

There is a need for more money, more advice, and more adequate personnel, as well as for better audio quality, smaller and better cameras, a good built-in pointer system for microtelevision work, a zoom lens with range from 4:1 up to 4X or 5X magnification, and an inexpensive, easily maintained color system of good quality.

PART II--BIBLIOGRAPHY: ABSTRACTS OF RELEVANT JOURNAL ARTICLES

Note

These abstracts cover the most important journal articles on television in medical teaching and research published in America since 1947 and several important ones published in Europe. Each abstract is identified by a classification number, the first portion of which identifies the subject section, and the second, the consecutive place of the abstract within the subject section. The subject breakdown and classification numbers are as follows:

Subject	Classification Numbers
Basic Sciences	1.1 - 1.9
Endoscopy	2.1 - 2.2
Eye, Ear, Nose, Throat	3.1 - 3.6
Microscopy	4.1 - 4.8
Postgraduate Education	5.1 - 5.7
Psychiatry	6.1 - 6.9
Radiology	7.1 - 7.35
Research and Diagnostic Instrumentation	8.1 - 8.10
Surgery	9.1 - 9.11
Miscellaneous	10.1 -10.29

Entry points into the abstracts are provided through subject and author indexes (see pages 149-155). In the case of multiple authorship, listing is provided separately for each author. For the benefit of those who may be new to the use of television in medicine, the following list of review papers may be helpful as introductions to the subject:

2.1	Ruhe
3.4	Warner/Brown
4.2	Bushor
5.1	Brown
6.4	Ruhe et al.
7.13	Janker
7.23	Morgan
7.24	Potsaid
8.10	Zworykin
10.1	Berci
10.3	Brown

The Abstracts

Basic Sciences

1.1 Geddes, L.A., Hoff, H.E., and Spencer, W.A. "The 'Broadcast Demonstration' in the Physiology Laboratory," Journal of Medical Education, Vol. 34, No. 2, February 1959.

For clinical studies the student uses the bedside to seek answers and to learn methods of arriving at solutions. The patient's very presence requires effective action and this requirement is central to the responsibility of the physician. Initiative and responsibility can thus be transferred from teacher to student. Because the physiology lab did not offer these advantages, the authors decided to develop a lab to include an instrumentation program, development of adequate physical environment with full educational and intercommunication aids, and a teaching program consistent with these goals. Because efficiency can be improved by minimum crowding, noise, and interference, and by maximum work space, illumination, and means of communication, the authors divided the available lab space into 10 small group labs. The authors wished also to foster the concept of the laboratory as permanently assigned quarters, where students can experiment and study at any time. Also set up were a demonstration theater seating 20 and a human-studies room containing much the same equipment as the labs, but with a single physiograph and a bed instead of an animal operating table in order to allow measurements on humans.

Each individual lab has recessed, starterless, daylight fluorescent tubes, running the room length, and two ceiling-mounted, color-corrected spotlights over each operating table. Physiographs and stainless steel sinks are flush-mounted into formica-topped cabinets that also provide compressed air and gas outlets and hot and cold water. Individual desk and drawer space is provided for each student. Ceilings are sound-absorbent and the labs air-conditioned. Both side walls of each room have fluted, translucent glass from counter height to ceiling in order to allow light, and there are no doors. Each room retains an outside window.

In a laboratory the student requires professional help and supervision. He also needs supplies and technical assistance. To meet these needs each station has a red, yellow, and green button, each of which flashes on his console and over his door when he pushes a button. The system extends to stations where demonstrators congregate, the supply room, the shop, and offices. Coded audible signals accompany the flashing light. Anyone may answer the signal in person or by intercom and the responsibility for canceling the signal then resides with him. No call can be canceled without releasing the button which the student originally pushed. The intercom system is so constructed as to make eavesdropping impossible.

Television is at its best for the demonstration, for by proper light and lenses each student can have a direct, even enlarged view. At each student console there is a TV receiver and speaker. Behind a small console door various connectors deliver graphic recording information. In the demonstration room a physiograph records the data and forwards the electrical signals to all student stations, while a 6-channel oscilloscope mounted above the blackboard can write either the same 3 channels that the pens are recording or 3 additional channels of information. Student questions and instructor answers are heard at all stations -- an asset in pacing. Since correlation of phenomena is a principal method of physiological study, the graphic record of demonstration reinforces its value.

The broadcast demonstration is genuinely valuable for a technically difficult preparation, an experiment undergoing development for future assignment, new transducers being designed for a particular array of physiological parameters, and events which are fleeting or unusual that could be witnessed profitably by a large group. When success depends on technique, the basic procedure in any experiment can be carried out quickly by an instructor. The principal phenomenon then can be broadcast to show that success in a difficult experiment is attainable. Student reaction can indicate what experiments need modifying before being included in the laboratory manual.

In physiology and medicine there is a lack of transducers to convert physiological phenomena to electrical signals, partly because many parameters are undefined and also because people with dual backgrounds in physics and biology are scarce. A prototype transducer is constructed from an estimate of the range of a phenomenon and suitability of a principle of transduction. After many demonstrations and improvements a transducer is evolved, compatible with event, demonstration, or lab assignment. During this development period, rarely seen physiological events are available to students.

The broadcast demonstration is assisting the authors, for example, in presenting certain aspects of the phenomenon of secretion. They recently exposed the heart of a giant turtle and applied stimulating electrodes to both vagi. A televised picture showed the class that the cardiac cycle started with the venosus beat, and myographs showed a 3-channel graphic record to all student stations. The new laboratory facilities reinforce the ability of the student in the lab program to understand and interpret results, broaden his experience, and teach him recourse to experimentation.

1.2 Geddes, L.A., Hoff, H.E., and Spencer, W.A. "Short Distance Broadcasting of Physiological Data," IRE Transactions on Bio-Medical Electronics, July 1961.

Medical schools and related institutions have laboratories making a host of physiological measurements routinely on patients, which are transmitted from the recording site to diagnostic location, monitored for therapeutic procedures, or used for teaching. The authors tried to apply appropriate segments of these data for teaching basic medical physiology. The task consisted of combining complex, existing equipment into a single system usable by untrained personnel without intruding on their daily activities.

In order to telemeter the available physiological data, analysis was made of existing apparatus into functional units to locate possible signal takeoff points. A transducer, processing amplifier, and a reproducer comprise the basic system of most modern electronic apparatus. This principle has been used to develop general-purpose student laboratory equipment and more refined apparatus for a clinical laboratory. The design of many commercially available electrographic instruments differs from this principle, substituting for the transducer a preamplifier which enlarges the bioelectric signals to a level acceptable to the main amplifying system, which in turn drives the reproducer (recording pen, galvanometer, or oscilloscope). The two takeoff points from which electronic signals are obtained are at the input to the main amplifier and at the reproducer. The only consistently available signal is across the reproducer. Electromechanical reproducers are second-best because of distortion introduced by the reflected mechanical impedance.

The problem was to select an appropriate takeoff point and transmit a signal of 1 or 100 volts over telemetry channels having adequate bandwidth and linearity and varying in length from a few feet to 2,500 feet. Extrapolation of data on the existing installation indicated need for adequate shielding to avoid serious interference problems. It was decided to install 24 shielded pairs in 1 shielded cable in buried conduit pressurized to 2 p.s.i. to keep out water seepage. To minimize cross-talk, 9 shielded pairs in another cable were provided. Two coaxial cables were also installed in the conduit, one for the television channel, the other a spare. Tests on the 2,500-foot physiological data pairs showed a pickup voltage of 100 microvolts open-circuit and 30 microvolts short-circuit. The lines were equalized to a frequency response from 0 to better than 5 kc. for the 25 percent attenuation point, operating at a theoretical signal-to-noise ratio of 10,000 to 1. The television circuit bandwidth was equalized to 6 mc. for the 30 percent attenuation point. Direct wire rather than a wireless system was selected because of cost advantages over short distances, ease of maintenance, and the fact that patients in fixed positions could be monitored by a bedside installation. The data are transmitted by direct wire to a master control unit that can receive three types of information from other departments or nearby hospitals, and the information is then directed to any of 20 student stations equipped to receive three channels of physiological data, a time and event signal, 2-way audio, and a television picture.

Much of the trouble anticipated with the long circuit did not develop. The only problem was design of suitable equalization networks that did not use inductive elements. The use of a standard pen-driving, direct-coupled, power amplifier transmitting the signal at high level required the use of a voltage-divider network at the receiving end to reduce the signal to a size acceptable to the recording apparatus and to restore the appropriate d.c. level. Simple capacitance compensation across a portion of this divider network achieved the frequency responses reported and resulted in a response time of 100 microseconds for the longest circuit and 50 microseconds for the shortest circuit.

1.3 Gosling, J., and Anderson, D. "Television in Teaching Clinical Medicine," University of Michigan Medical Bulletin, Vol. 27, No. 6, Nov-Dec 1961.

Prior to using television for demonstrations of gynecologic surgery, the Department of Obstetrics and Gynecology experienced difficulty in presenting a really adequate view of operative procedures. With the camera directly above the scene, the observer's field of vision is now as good as the surgeon's. Varying the size and magnification of the field makes the presentation even more satisfactory. A planned approach that follows the surgeon's commentary and procedure is important. Such an approach is facilitated by assigning a physician familiar with the problems of both surgeon and television director to sit beside the director and keep him constantly advised of points to be demonstrated. He can also serve as moderator in the chair of communication between audience and surgeon, making certain that the surgeon's commentary covers all points demonstrated on the screen. Since the surgeon cannot readily observe his own screen presentation, such an intermediary is important, but the ultimate success of the presentation still depends on the demonstrator's ability to maintain a clear, pertinent commentary on the procedure. The picture can supplement, not substitute for, the spoken word. Loss of some depth perception is not crucial, but carefully focused camera work is required. Color is advisable to provide a sense of texture and subtle color values of tissues and fascial planes, which are largely lost with black-and-white television.

Television in the delivery room has overcome the difficulty of showing an actual delivery to a large student group in the introductory course in obstetrics. Now the classroom instructor can comment and the students ask questions during the delivery without risk of the patient hearing and misinterpreting the commentary. Thus, classroom groups of a size untenable in the delivery room can be given carefully supervised firsthand observation in a remote location. It is extremely effective to go directly from a teaching point to a direct demonstration, to an immediate follow-up critique, all within the confines of a classroom.

The value of television is more limited when teaching skills and attitudes of the gynecological examination. Visual aspects of the examination may be televised but no amount of graphic demonstration can possibly substitute for digital palpation. Dermatologists have used television extensively to demonstrate visual lesions, but once again, both practical logistic and privacy problems limit the use of television in illustrating visible lesions of the external genitalia. Color slides remain the preferred method of dealing with this subject.

Any clinical department can strengthen its program through providing basic lab work. Existing techniques have tended to exclude much of this type of presentation. Television now makes it possible to bring such demonstrations to groups of any size. It is particularly well suited to various bioassay and animal techniques and to microscopic and anatomic demonstrations. These presentations require careful planning, preparation of good specimens and graphic aids, and teacher and crew rehearsal. To be effective, the whole program must move smoothly and clearly within a specified time.

Gynecologic and obstetric demonstrations must recognize the restrictions imposed by the feelings and privileges of the patient. Increased complexity develops with substitution of an impersonal television camera for the sympathetic physician, and of a remote audience of uncertain size for a small group of students. It is therefore absolutely essential to explain the entire procedure to the patient beforehand and obtain her written consent. Television in obstetrics and gynecology is a useful teaching aid, but it is no substitute for good teaching.

1.4 "Inter-Connecting Basic Science and Clinical Facilities by Television," Address by Dr. Walter L. Hard, Dean of the State University of South Dakota Medical School, at the Fourth Annual Meeting, Council on Medical Television, May 1962.

Existing medical school facilities are inadequate for the needs of expanding populations, increased demands for medical services, and research. Clinical centers could be expanded with sufficient funds, but there is concern for teaching effectiveness if they are overexpanded. Four-year schools cost $20 to 30 million to build and operate.

The medical school dropout rate runs 5 to 20 percent, most of it during the first 2 years. This loss is economically significant when tuition approaches an average of $1,000 a year. It is unsound to leave these vacancies unfilled, but the only source of recruits is the 2-year, or so-called basic-science school, which can be built for a fraction of the cost of a medical center. The author has had 14 recent inquiries from institutions in 11 States about the operation of a 2-year school. Many of the inquiries revealed that these people mistakenly felt that the addition to existing curricula of a few specialized courses in anatomy, biochemistry, and pathology would provide for a 2-year medical school on an existing liberal arts campus. The medical-education accrediting agencies have understandably taken a dim view of any medical education that does not heavily emphasize clinical medicine in the first 2 years as well as later in the curriculum.

In the absence of local clinical facilities, the curriculum at South Dakota normally includes about 100 teaching-hours of clinically correlated material during the first year, and about 400 teaching-hours of specific subject areas in the sophomore year -- an amount of time devoted to clinical presentation exceeding that of any single course offering. Didactic lectures are given on medicine, surgery, pediatrics, ob/gyn, radiology, and psychiatry, and clinical case presentations are introduced throughout the year. Second-semester students actually perform physical diagnostic procedure and case history preparation and learn psychiatric interviewing techniques.

The 2-year medical school must have all the facilities of the 4-year school, differentiated only in scope and quality. Most schools considering a 2-year medical program have clinical facilities away from the campus, and time and financial outlay are expended in traveling. At South Dakota, if clinical instruction were televised, 150 hours a year could be salvaged for uses other than transit. Some clinical presentations would be enhanced considerably by television, such as surgical, topographical, and radiological anatomy. The

2-year school can evaluate its program effectiveness by comparing its transfer students with native students in the 3d and 4th year.

Television for institutional clinical instruction offers a unique experimental situation. The equipment would be available for teaching basic science and for special undergraduate and postgraduate programing. Although expensive to install and operate, telephone facilities are often available at educational rates to cut transmission costs.

1.5 Keasling, H.H., Gross, E.G., Long, J.P., Pittinger, C.B., Fouts, J.R., and Shipton, H.W. "Report on the Use of Closed-Circuit Television in the Teaching of Pharmacology," *Journal of Medical Education*, Vol. 35, No. 9, September 1959.

The use of closed-circuit television in medical, dental, and pharmacological laboratory teaching was prompted by the need to replace old equipment. Rapidly changing trends in pharmacological research methodology made it difficult to choose equipment to serve future needs. The flexibility of television teaching eased the choice by allowing courses to function with only one set of lab equipment.

The Iowa pharmacology department operates lab courses by advance preparations of procedure, thus maximizing student time for observing and understanding drug actions. The demonstrations were performed by the students. If the staff demonstrated instead, there would be lack of visual contact between student and demonstration. Closed-circuit television overcomes this disadvantage.

Television demonstrations are held in a classroom seating 60 students. Direct vision is possible but inferior to the view on the television screen. The lecturer supervises the demonstration to correlate it with his discussion, halting the procedure if desired to answer questions or to repeat portions. The equipment is light-sensitive enough to permit ordinary room lighting, enabling students to take notes. Before class, one camera is focused on the record, the other on the preparation. They seldom need adjustment since the areas viewed are not changed. Because more than one preparation is generally utilized during a period, demonstrations previously prepared on wheeled carts are set up during a 5- to 10-minute break.

The equipment is easier to operate than a home TV set. It consists of two cameras and control units and two 21-inch monitors, all chosen for simplicity. This black-and-white system was cheap and adequate for the authors' purposes. Standard 16mm "c" mount lenses are used. Automatic sensitivity-control protects the vidicon tube from damage that in other systems results from maladjustment of camera controls. Large changes in ambient lighting are automatically compensated and sensitivity is sufficient to provide reasonable depth of field. The equipment cost $8,000, including shopwork on a camera stand. A portion was recovered by decreased cost of lab animals. Contrary to expectations, staff lab teaching time is relatively unchanged; in fact, initially, it was greatly increased. Visual magnifications provide students with a view often superior to that of demonstrators watching the preparation. Students do not seem distracted from their work by the equipment. Complexity of the biological preparation and recording apparatus is limited only by staff competence and availability of equipment. In other respects television presentations seem to make little difference.

Demonstrations previously difficult to present to a large class, but now standard, include effect of drugs on the isolated rabbit heart, preparation of Langendorff, localization of site of action of ganglionic blocking agents utilizing pre- and post-ganglionic sympathetic stimulation in the cat, effect of quinidine on the driven dog heart, tests for anticonvulsant activity in mice, and records derived from various types of transducer electronic-amplifier pen writer systems.

In the absence of formal analysis, staff members have observed marked improvement in lab attendance, better exam scores by the present class, and favorable reaction by the students. Part of this effect may be due to decrease in time necessitated for lab courses (50 percent reduction) and novelty effect, but the staff feels that this method of lab instruction is far superior to previous methods.

1.6 McGuire, F.L., Moore, F.J., Harrison, C.A., and Riley, R.E., Department of Psychiatry, University of Mississippi School of Medicine, Jackson, Miss. "The Efficiency of Television as Applied to the Use of Laboratory Demonstrations in Teaching," Reprinted from The Journal of Medical Education, Vol. 36, No. 6, June 1961.

Analysis of educational closed-circuit television reveals that its use in colleges and universities for undergraduate work does not significantly affect the difficult problem of quantity. The use of television in laboratory demonstrations, however, still needs to be evaluated. Because lab demonstrations are of necessity limited in audience size, experiments had to be repeated several times. Many medical schools were forced to eliminate certain demonstrations because repetition was too expensive. Closed-circuit television could circumvent this difficulty and also allow additional demonstrations. Therefore, in laboratory science, television could provide more teaching-time and enriched curricula.

In order to test the quality and judge the teaching situation, the University of Mississippi School of Medicine exposed two academically matched groups to a standard pharmacology laboratory presentation. The first group of 16 students was present with the instructor, and the second group of 44 students viewed the same demonstration on two television monitors -- one focused on the instructor and/or subject, and the other on an experiment-related recording device. Both groups were able to ask questions, the second by means of a 2-way voice circuit controlled by an assistant in the television classroom. Immediately after the demonstration both groups answered a quiz on the material presented. The results showed practically no statistical differences between the two distributions of test scores. Within the limits of this study it was concluded that the use of closed-circuit television in medical education does not detract from the quality of the teaching situation.

The study also showed the various kinds of laboratory equipment that do not televise well. This is especially true of small, light-colored electrodes and fine wires. Students in the television group inquired repeatedly about some of the equipment. It appears that simple viewing cannot always be assumed to equal the live event, but that direct communication with the instructor helps to compensate for unforeseen limitations. Further production techniques will have to be developed.

1.7 Markee, J.E., Agnello, S.A., and McFalls, F.D. "Closed Circuit Television for Examinations in Anatomy," Medical and Biological Illustration, Vol. 12, No. 1, January 1962.

Duke University Medical Center used television to test anatomy knowledge of 1st-year medical students and to emphasize testing of visual learning. All examinations were structured to become part of the learning experience. During examinations, the professor remained with the students to show films and to relay questions to demonstrators or communicate suggested adjustments to control room- and camera-men. One instructor-demonstrator in the dissection room displayed cadavers, models, live subjects, etc. A second instructor-demonstrator in the control room posed questions about multiscanner displays. A younger faculty member served as camera-man. A director-coordinator in the control room operated switching controls, timed the question period, and relayed pertinent information to team members by intercom. The dissection room contained camera and allied equipment, cadavers, live models, x-ray viewing boxes, and radiographs. The control room housed multiscanner equipment, monitors, switcher-fader, patch panel, and audio equipment. The classroom contained students, senior faculty member, and four 21-inch monitors for student groups.

The questions to be answered and the visual and audible orientation were given at the beginning of a 90-second visual material display period. The typewritten question was then superimposed for about 10 seconds. At the end of 90 seconds, the visual presentation faded to black, and the question faded in to remain another 20 seconds. After 10 seconds of dark screen, the next sequence followed. When linked with color film material, the question remained throughout the 120-second period.

Advantages over the walk-around examination are as follows: enlarged scope of exam (dissected material, models, illustrations, live subjects, and motion pictures), same view to all students, audibility of student questions and instructor answers to the whole class, and use of varied instructors so that a number of viewpoints are available. For practical examinations it is possible to set up an integrated sequence of questions based on area, systems, or functions. A majority of students expressed preference for this type of test (which may not be an advantage).

Precautions to safeguard the method included rehearsal; answering of student questions in such a way as to help orientation without giving away the test answer; the reading aloud of the superimposed question over the picture by an instructor; and precautions against limitation of questions because of equipment and technique. Color movies supplied pictorial sequences where color was essential.

Television seemed useful in testing visual knowledge and comprehension of anatomy in relation to clinical medicine. Without limiting class size, it permitted testing of primarily visual material; simultaneous presentation of live visual material to the entire class; and, through presentation of a sequence of materials, the testing of understanding of concepts as well as knowledge of isolated facts. The test scores were positively correlated with those from other types of examinations, but the degree of correlation (.75 with walk-around test and .66 with multiple choice) demonstrates the advisability of further studies to establish what information can be tested most effectively by each type of exam, and the relation of these test scores to clinical practice.

1.8 Swain, H.H. "Basic Science Teaching with Television," University of Michigan Medical Bulletin, Vol. 27, No. 6, Nov-Dec 1961.

Teaching pharmacology requires varied approaches such as lectures, textbooks, and firsthand student experience with drug actions. Actually, students lack the technical lab skills necessary for the more complex drug demonstrations, but are able to profit from the instructor's demonstration. Prior to closed-circuit television, demonstrations were plagued by general invisibility beyond the first row. The problem was met by dividing a class into small groups and repeating each demonstration. This method was costly in time, effort, and material.

With television, each student's view is clearer than from the front-row seat. Since one performance suffices, faculty members exert additional effort to make the single demonstration each year a success. At first, televised demonstrations originated from the back of the room in which the lecture took place. Students watched on the image projector screen in front or on the 21-inch monitors at the sides. This system kept the instructor in the room with the students, but presented technical difficulties.

Demonstrations are currently performed in the television studio and are carried to the audience in another building. It is difficult to gather all the necessary equipment and take it to the studio, which simply is not equipped for biological research. Nevertheless, quality of the televised image and camera, and control versatility make the move and mess seem worthwhile. The cables connecting studio and audience carry both the color image and a 2-way telephone circuit. Thus, the demonstrator is heard over the public address system in the amphitheater as he demonstrates, and he can receive feedback from the class through a staff member whose voice is heard over the studio loudspeaker.

Television has proved especially useful in demonstrating the action of drugs on the heart's rhythm. The camera lens is brought within a few inches of the heart in order to enlarge the most exciting square inch of atrial surface to a square several feet on a side on the screen. A 2-camera setup enables the lecturer to demonstrate the correlation between heart activity and its electrocardiogram. The electrocardiogram is recorded on a cathode-ray oscilloscope and picked up by a black-and-white television camera. Simultaneously, the color camera follows the action of the heart itself. The two images are mixed in the control room so that the electrocardiogram appears as a white line moving across the color picture of the heart. The demonstrator can speed, slow, or stop the heart for a few seconds and the student can see how changes in heart action are reflected by the electrocardiographic tracing. Other topics demonstrated by television include drug antagonism, responses of the peripheral circulatory system, and clinical anesthesia.

It is tempting to tape a currently successful demonstration to save future preparation. Also, other medical schools have requested that Michigan record some of these demonstrations so that they may use them in their teaching. The writer feels that such recording would not only take on the limitations of film, but, if prepared under conditions of a television broadcast, would suffer in comparison to a well-made movie. The outstanding characteristic of televised demonstrations is their spontaneity. Students see what happens, and what they see can be changed at their request. Thus, the demonstration is not an end in itself, but a means of conveying some of the relationships that constitute the subject matter of the course.

1.9 Woolsey, F.M., Ruhe, D.S., ppenheimer, M.J., Kabisch, W.T., Davis, G.D., and Foster, J.E. "The Use of TV in Teaching Physiology and Anatomy," *Journal of Medical Education*, Vol. 31, No. 2, February 1956.

The authors represent five medical schools currently using television to teach basic science. These institutions were variously interested in television as a logical extension of a fluoroscopic image-intensifier, a means of improving physiology studies of small details, and of helping freshmen appreciate the color, consistency, and plasticity of living tissues and organs (through televising surgery). Finally, they were interested in exploring the feasibility and practicality of intramural TV. All five schools found television extremely valuable for presenting small fields of phenomena to large groups.

It appears that television can make certain demonstrations clearer, such as reaction of the heart to nerve stimulation, drug injections, and defibrillation procedures; with surgical demonstrations, it has the added advantage of causing less disturbance to operating room routine. Electrophysiological techniques that use the small oscillograph screen and electroencephalography, where the recording machinery is in a small room, can be viewed by a whole class via television. The television image amplifier eliminates the need for dark adaptation and increases sharpness. It is now possible to teach and observe gastrointestinal applications easily.

Equipment at the five institutions is used for intramural teaching. The camera and receivers are housed either in the same room with the students or in rooms that can be connected by cable, depending on whether the school considers the camera equipment a distraction. The type of equipment varies from a simple black-and-white camera chain to a very expensive field sequential color setup.

Correlations cutting across departmental lines have proven very fruitful in teaching and research. For example, physiology, radiology, and medicine joined to use TV to visualize the use of carbon dioxide gas in the intracardiac structures *in situ* and demonstrated the safety of this gas. Clinically, TV has been used with the image amplifier, in neurosurgery, to place Horsley-Clarke electrodes; in preparation for heart surgery, to observe angiocardiography; in gastroenterology, to demonstrate cardiospasm and disturbances in swallowing; and in orthopedics, to visualize venous drainage from bodies of vertebrae.

Although television is expensive, the authors do not regard it as excessively so in light of increased teacher-time and new presentations of material that could not previously be presented well. There are few categories of medical education in which television cannot be used successfully as a visual aid, and it is safe to predict that it will eventually communicate phenomena beyond the scope of research and teaching tools available at present.

Endoscopy

2.1 Ruhe, D.S. "Advances in Endoscopic Motion Pictures and Television in the United States," Sonderdruck aus Research Film, Vol. 4, No. 2, 1961.

Some of the obstacles to endoscopy are obtaining sufficient light without too much heat for photorecording, seeing around corners, and teaching diagnostic therapeutic procedures through a shared image. Coaxial lighting has been urged as a means of meeting the constant pressure for adequate lighting. Compromise, such as a ring of lights, has not been practical except for large incisions. A camera complex developed in 1959 incorporated a more efficient light system, and a simplified version with newer projection bulbs and more mobile suspension devices could find the needs of many types of threshold endoscopy. A simple and almost coaxial light system, incorporated into a helmet-mounted television camera, used the periscopic principle for otolaryngological teaching and observation. Film recording could be easily added by combining the best of both these devices.

The principal developments in endoscopy are the flexible glass "fiberscopes," which offer light and picture pipes able to pass easily around less acute curves of the body tubes. Fiber or tube endoscopes combined with television fluoroscopy suggest more flexible radiological and visual access to such areas and surfaces as the ventricles of the brain and blood vessels. The idea of bundles of glass fibers transmitting a picture mosaic has been under development since 1927. It is applicable to dentistry, gastrointestinal pathology, and physiology, among other areas. Exploration of every human cavity with increasingly ingenious instruments combined with fiber optics promises a family of diagnostic instruments for every practitioner in his office.

It is obvious that television cameras will be coupled to bundles of glass fibers. Light passage is sufficiently great, through excesses of distally available cool light, for many kinds of field illumination and picture pickup.

Great progress has already been made in technical handling and treating of the bundles, and extensive investigation is now determining durability, resistance to stress, replacement costs, etc.

In this era of electronic devices, radiology and endoscopy have interlocking relationships to research and certain diagnostic procedures. We are on the threshold of simultaneous film recording by endoscope and fluoroscope in research on functions of the upper gastrointestinal tract, possibly recorded on film or videotape from a split television screen. Other improvements will lead to work with the biliary tree and pancreatic duct, the cavities of the brain, tubes in the middle ear, the sinuses, and the relatively inaccessible hollows of the nose.

2.2 Soulas, A., Dubois de Montreynaud, M., Edwards, R., and Gladu, A. "Bronchoscopy and Television," Diseases of the Chest, Vol. 31, May 1957.

With a new type of bronchoscope with a proximal light source, a telescope, and a quartz rod to transmit the light to the distal tip of the instrument, sufficient illumination was provided to permit attaching a television camera directly to the endoscope. The first experiment, involving France's Television Nationale, took place in 1955 for the purpose of relaying an endoscopic view. The same view seen by the bronchoscopist and his assistants on the screen in the operating room was also visible on individual television sets to those outside. This experiment proved it could be done. There may be practical social and prophylactic interest in so utilizing a national television network, and there may also be value in permitting a distantly located bronchoscopist to give an opinion. The complicated knowledge required of an operator, however, may limit this use. Bronchoscopy films might be more feasible for consultations.

The second experiment, performed in a university hospital, was transmitted only to the bronchoscopist, his assistants, other physicians, and medical students. Again the special bronchoscope had to be adjusted to the camera, in this case a privately produced camera, greatly reduced in volume and weight (3 pounds). The televised image allowed all present to view the procedure and the bronchoscopist worked directly from the television screen rather than from direct inspection. This picture was transmitted to several auditoriums to serve medical personnel, with commentary relayed through a loudspeaker.

Eye, Ear, Nose, Throat

3.1 House, H.P. "A Closed Circuit Television Camera for Teaching Microsurgery of the Ear," Transactions of the American Academy of Ophthalmology and Otolaryngology, Vol. 66, March-April 1962.

Several years ago the writer presented an observer's tube and motion picture camera that a demonstrator could attach to the binocular assembly to provide a surgeon's view to the observer or camera, without compromising either patient or surgeon. Because a single tube proved inadequate for the multiple observers in the operating room, the 20-pound camera was condensed into 3 pounds, the new unit having excellent balance and uncompromising usability, to replace the single observer's tube. Single or multiple monitoring television screens are used for closed-circuit viewing. The camera is easily removable from the microscope for other types of general surgery, and therefore is generally adaptable for teaching surgical procedures.

3.2 Moore, P., and von Leden, H. "Television in Otolaryngology and Other Specialties -- A New Teaching Device," Journal of the American Medical Association, Vol. 169, No. 17, 1959.

Clinical, surgical, and classroom teaching have been handicapped in dealing with cavities of the ear, nose, and throat because they can be examined and viewed by only one person at a time. This problem is sometimes met by placing a small mirror near the viewing axis to reflect the image to a second observer, but the view is still limited to this one additional viewer. Still- and motion-picture photography have been used, but although these display the material to many viewers, they lack the immediacy of the clinical presentation. Teaching methods would be improved greatly by showing a specific area in a deep body cavity to any desired number of observers at the moment of examination or treatment. Such procedures are common in general medicine and surgery, where standard lighting and camera techniques apply, but conditions are different when the field of observation lies within a restricted channel, obscuring a direct camera view. The fundamental requirement, therefore, for simultaneous viewing of the head and neck cavities is a positioning of the equipment in the optical axis of the examiner while retaining his freedom of sight and movement for any manipulation. This requirement has been met with a practical pilot model of a television-scope.

ment. Such any desired number of observers at the moment of examination or treat-

The mechanism rests on the examiner's head and the camera gathers its picture by means of a periscope lens, the foot of which lies directly before the examiner's eye. The light from the subject travels simultaneously to the eye of the examiner (through a minute clear area in the center of the angled mirror) and to the television tube by way of an angled mirror, lens, and prism arrangement. The lens is fixed and the vidicon tube adjustable either manually or by remote control for focusing. The clear area in the mirror through which the examiner views the subject area is out of focus and thus does not show up in the television picture. A counterbalanced arm and sling arrangement assists in lightening the 18-pound load without interfering with the examiner's movement.

A beam from a small high-powered lamp attached to the periscope lens is directed to the critical area automatically, leaving the examiner's hands free. This method supersedes the old method of concave head mirror, which provided limitless, reflected shadow-free light, but required adjustment each time either the examiner or the patient moved.

The authors believe this equipment is especially helpful in the clinic, classroom, and operating room, and in postgraduate education, for extending teaching procedure to otolaryngology and other surgical specialties dealing with deeply placed structures. Its application has demonstrated the effectiveness of a television camera and associated periscope lens system supported on the head of an examiner in improving clinical instruction. The program has also revealed that four specific and interrelated modifications would increase the effectiveness of the equipment: increase in the depth of field, variation of field size, helmet modification to permit support in vertical as well as horizontal planes, and the introduction of color television.

3.3 Potts, A.M., West, S.S., and Shearer, J.R. "Application of Television Ophthalmoscope to Some Problems of Clinical Ophthalmology," AMA Archives of Ophthalmology, Vol. 62, September 1959.

The image orthicon tube treats the picture focused upon its face by the camera lens as a series of horizontal lines composed of dark and bright spots. This information is converted by the scanning process into an electrical signal and transmitted to the television receiver, where the lines are reproduced to form the picture in its entirety. It is possible to select and display any single line on a cathode-ray oscilloscope. If an image of the fundus oculi is so viewed, a line may be selected which runs through an anatomical feature of interest or through a pathological lesion. If illumination is monochromatic, the amount of light sent into the instrument from any given eye region is a measure of the reflective absorption of that region for the wavelength used.

Because of the complex nature of light reflected back from the fundus, the effect of different lesions on reflected light varies with their nature and position in the retina. Analysis of data produced by the line-selector is further complicated by the nonlinearity of the image orthicon tube, which not only lacks linear output variation with varied light intensity, but also varies in light sensitivity with wavelength of the light used. Technical measures can compensate for these factors to calibrate the instrument. The method obtains quantitative information about relative reflection-absorption of any two retinal areas and then compares them. Much qualitative information may be had from simple inspection of the photographs of the monitor at various wavelengths.

Even in the qualitative use of television ophthalmoscopy, there are such advantages as the capacity to examine the integrity of the pigmented macular area at high contrast with the short-wave end of the spectrum, and of the choroidal vessels and pigment at the opposite end. The instrument is superior to visual observation at these wavelengths because of lowered sensitivity of the eye to extremes of the visible region. Television tubes are available with high sensitivity to red and infrared or extreme violet and ultraviolet, which allow examination on the monitor in black-and-white with photopic visual acuity.

In television photography, the results may be seen immediately; slight changes in angulation may be performed for multiple views; dynamic events may be observed; and the subject is not dismissed before all pertinent information is obtained. The instrument has application to selected cases of macular disease at this time, and an extension to many other types of visual lesions is envisaged. With the high rate of technological development in electronic image processing, new tools may soon be available to expand its potential.

3.4 Warner, L., *and* Brown, M. "Techniques for Studying Microcirculation in the Eye," *Anatomical Record*, Vol. 138, December 1960.

Advances in knowledge about eye structure have been most rapid after introduction of new instruments and techniques. The Greeks and Arabs made macroscopic observations and understood a great deal about the retina, but physiological optics awaited the magnifying glass, and histology of the eye, the microscope. In our own century advances in chemistry, optics, and electronics have been applied to structure and function of the nervous component of the retina. The ophthalmoscope allowed the pathology of the vascular system of the retina to be correlated with systemic disease. The instrument permitted *in vivo* study of circulation in the eye.

Early studies were handicapped by having to depend on the subjective evaluation by a single observer of events that were rapid and transitory. The motion picture camera in joint use with a microscope provided a new approach to the study of retinal and choroidal circulation. Sixteen-mm color motion picture film and methods of illuminating tissues such as the fused quartz rod made possible permanent records from which measurements could be obtained and events reviewed by multiple observers. As a result, a variety of flow patterns in small vessels was recognized, and the occurrence of aggregate formations in these vessels under conditions of physiological stress was established. A motion picture camera for retinal photography that made low magnification recordings using fast color emulsion had serious limitations, but did much to advance teaching. The prospect of studying circulation within the eye through the pupil remained an exciting challenge, since this is the one readily available route. This circulation study is important, since it represents a sample of the blood supply to the brain.

Further progress occurred when electronic image processing provided higher magnification, more light, greater sensitivity in the sensing system, and more precise methods of measuring. Electronic image processing is a method of converting a visual image to an electronic signal that may be processed to extract information in usable form, whether a reproduction of the image, a visual representation of some information contained therein, or some type of digital readout. Television is one such system and its variant forms provide much basic technology. The application of television systems to biology began with the television microscope in the late Twenties but technical difficulties delayed practical application. The challenging potential of this type of biological instrumentation is largely unexplored. Current developments include exploration of biological phenomena with ultraviolet, light intensification in connection with fluoroscopy, and television ophthalmoscopy. Electronic engineers have not explored the processing technology beyond the requirements for television and telemetry.

Early television ophthalmoscopy was demonstrated in color in 1947, and a black-and-white version employing a flying-spot scanner presented the ocular fundus on the screen for teaching and group diagnostic consultation. In 1955 an image orthicon camera viewed the retina in black-and-white and recorded a case on 16mm film. This created a permanent record of the dynamic factors in the pathologic process and a means of obtaining crude measurements of the structures. A living frog mesentery circulation was also recorded on film in color, using television as the viewing means. These films showed the advantage of electronic image processing in permitting lower light levels and image amplification as well as enhancement of color to bring out overlooked information.

In 1957 supersensitive orthicon camera tubes made it possible to view the retina with a field sequential color camera at light levels comparable to the focusing light employed on the retinal camera. A television ophthalmoscope technique consists of examining a single horizontal line to measure certain characteristics with precision. Each black-and-white television picture is made up of 525 horizontal lines electronically traced across the picture tube 30 times a second. Each line is started by an electronic pulse and requires a finite time for its tracing. Findings must be interpreted cautiously and with a sound knowledge of the entire optical pathway. Nevertheless, important data can result from studying the absorption of light of known wavelengths by structures in the eye, using this method.

The color television ophthalmoscope may be adapted profitably to animal studies. A neurosurgical group worked with cats to yield physiological and pharmacological information related to retinal circulation. The first successful optical and illuminating system employed hand-ground lucite lenses to neutralize the corneal curvature of the eye. A standard lens was used later on, with some gain in resolution. The authors had hoped to employ the "crispening" technique, which separates out the fine detail in the picture represented by the higher frequencies in the electronic signal, but while it worked well with lower-resolution cameras, they were not successful in adapting it to the new research camera, which employs a much wider video band pass.

Instrumentation for this area of biological science is still clumsy, difficult to manipulate, expensive, and electronically complicated. The optical system of the eye itself presents serious difficulties in resolution. The authors are interested in developing more quantitative instruments. They are currently studying a system of color TV using three sequentially pulsed, monochromatic light sources for illumination of the eye to eliminate filters between the eye and camera tube. This system would have to be simple, inexpensive, and conveniently packaged to be useful. Consequently, they are experimenting with converting an ultrasimplified black-and-white industrial vidicon camera system and suitable optics to ophthalmoscopic use.

Flying-spot technology has good potential. Here, the television signal is created by illumination of the viewed object with a black-and-white raster from a picture tube and focusing of the flying-spot on it. Light reflected from the object is seen by a photo tube which reports to another flying-spot seen on the viewing tube. When the two flying-spots are synchronized, a picture appears on the viewing tube. This technique favors biological observations because of lower tube illumination and almost heat-free light. Such electronic processing offers a variety of changes by simply sending a portion of the signal or a signal derivative back to the illuminating tubes. It can be used in black-and-white or either of the American color systems. Limits to its usefulness derive from low light level from the illuminating tube, which hampers development of either a flying-spot microscope or ophthalmoscope. The required high voltage and clumsy physical size also cause difficulties. The authors are hopeful for development of a flying-spot ophthalmoscope for human use and research in animals.

Electronic image processing devices are very low-resolution systems. Higher resolution can be obtained by nonstandard means, but such circuits and components create difficult operating and maintenance problems and higher costs. Also, desired results that are theoretically possible usually prove unobtainable. The authors' experience indicates that it is more profitable to rely upon increasing optical magnification and to improve the electronic element by reducing noise and processing the signal for desired information.

3.5 Werner, L., and Brown, H.C. "Electronic Image Processing: An Approach to the Study of Choroidal Vessels," Bibliotheca Anatomica, Vol. 1 (European Conference on Microcirculation, Hamburg, 1960), 1961.

The term "electronic image processing," suggested by Kovasznay and Joseph, describes the conversion of a visual image into an electronic signal to extract information in usable form. Television, with its light, contrast, and size amplification, is one such system.

Biological instrumentation such as the television microscope has been used, but remains largely unexplored. Current developments include viewing biological phenomena with invisible (ultraviolet) light and making practical use of light intensification for fluoroscopy. Loeser characterizes living tissues by monochromatic light absorption, but biologists, like electronic engineers, have largely overlooked the potential of advanced TVimage processing technology.

Considerable attention has gone into developing the television ophthalmoscope. In 1957 supersensitive orthicon camera tubes allowed viewing of the retina with a field sequential color television camera at light levels of a standard retinal camera, and color motion pictures were made of a number of human retinas.

Line-selection technique permits examination of a single horizontal line of televised information. In a field of small blood vessels televised under microscopic examination, we can measure the width of any vessel and its density on a cathode-ray oscilloscope. In the eye, this technique can be made quite quantitative. Studies of light absorption by eye structures can yield important data.

In 1959 the authors attempted to photograph the life history of toxoplasma lesions in the retina of infected rabbits, using a modified color television ophthalmoscope and a color television motion picture recorder. The television ophthalmoscope allowed ready visibility of the choroid circulation in the albino rabbit. Simple pharmacologic experiments made comparison possible with reports of other techniques. Line-selection tracings from the oscilloscope were photographed at the beginning and end of each sequence. Many results differed from other reports, a discrepancy which led to examination of deficiencies in the present instrumentation. These included physiological objection, i.e., the contact lens as a trauma source and the necessity for dilating the pupil, causing chemical and pharmacological variables. The microscope and illuminator are not ideally adapted to the field and illumination is uneven, with little depth of focus or internal reflections. Low objective optical magnification results in limited resolution, but the authors' findings are sufficiently consistent to justify seeking better optical systems. The fact cannot be overcome, however, that the choroid is being viewed through a number of structures superficial to it in the optical pathway.

A new illuminator is being developed to employ three bands of monochromatic light that can be selected at will. By using each light-band sequentially to illuminate the eye, the color filters between camera and eye can be eliminated. The color wheel absorbs about 60 percent of light reflected by deeper structures of the eye and a significant gain in effective sensitivity will result. More specific knowledge will be obtainable of variations in light absorption by the constituent tissues of the eye when monochromatic light is employed. If the bands selected are related to important physiological phenomena, such as absorption peaks for oxyhemoglobin, reduced hemoglobin, and methemoglobin, certain significant information about circulation in the choroid will become available for the first time.

3.6 West, S.S., Potts, A.M., *and* Shearer, J.R. "Television Ophthalmoscopy," *IRE Transactions on Bio-Medical Electronics*, Vol. BME-9, No. 2, April 1962.

The retina of the living eye allows clinician and researcher not only to study retinal characteristics, but also to learn something about the general body condition. Work with the optical system presents difficulties because light absorption of retinal pigments and choroid, with their diffuse reflection properties, returns only a minute percentage of light through the pupil, and a portion of the pupil must also be devoted to illumination. The useful illumination level is too low to allow filming of the retinal field normally covered by the ophthalmoscope, but increased illumination would cause retinal damage. Reducing the optical resolution minimizes these difficulties. Therefore, the retina is normally examined visually by a single observer, and illustrations usually consist of drawings and of still photographs. Television ophthalmoscopy overcomes these difficulties. Also, in combination with monochromatic illumination and analysis of selected television lines, it provides a unique potential for new retinal data.

Ophthalmoscopy with restricted spectral bandwidths was tried as far back as 40 years ago when "red-free light" and photography, or photomultiplier tubes, were investigated. Microcirculation of the eye has been studied this way. The instrumentation described in this paper shows how selected television lines are used to obtain data.

The carbon arc of the television ophthalmoscope was replaced by a zirconium arc lamp, while the original illuminating-optics and aspheric objective-lens were retained. A high-aperture camera objective replaced the optical system behind the prism. The high-voltage supply for the control unit monitor was replaced to eliminate RF in the signal. An image orthicon tube was used.

Line selection is accomplished by sending horizontal synchronizing pulses from the synchronizing generator to the input of the dual preset counter. One counter is set to recycle after a count of 525, and the other, to select any given line number within this count. The pulse produced by the second preset counter unit is fed to the variable-time-delay generator, which is part of the oscilloscope, or to the external sync input of the oscilloscope. The first way permits considerable sweep expansion and jitter-free video signal. The second way is used when the entire television line is to be examined. The unblanking gate on the oscilloscope is fed to the video amplifier of the camera chain monitor and mixed with the video signal to provide a bright line indicating the portion of video signal being displayed by the line-selector oscilloscope. The video signal is fed to both the monitor and the vertical input of the oscilloscope.

Drugs are used on the pupil to avoid contraction from illumination to the point of interference with the procedure. Interference filters are interposed between the lens and prism as needed. The face of the prism facing the subject is blacked out except for a narrow horizontal strip. The objective lens of the ophthalmoscope produces a reduced image of this strip on the cornea, at the edge of the pupil, and the remaining pupil produces an aerial image of the retina behind the lens. The camera objective lens brings this aerial image to a focus on the fact of the television camera tube.

The picture monitor and line-selector oscilloscopes are at right angles to each other, permitting simultaneous photographing upon a single 35mm frame, through a dichroic mirror mounted at an angle on the film camera lens. The complexity of the retinal field makes it mandatory to record the line-selected trace along with the monitor presentation and to indicate which portion of the video signal the line-selector shows. Without this aid, interpretation would be extremely difficult.

The line-selector trace must be corrected for nonlinearities inherent in the equipment: photocathode sensitivity varies with wavelength; the camera tube gamma varies with position on the photocathode, wavelength, and intensity of illumination. Measurements were made with an artificial eye having a flat magnesium carbonate "retina." Absolute light levels were not measured, but rather, video levels produced by the living eye were reproduced. Thus, the true dependence of camera tube gamma upon the wavelength of the photocathode illumination was not determined by these measurements.

The neutral-density filters are used both for calibration and to reduce illumination intensity, and operate below the knee of the camera tube light transfer characteristic, thus avoiding saturation and providing greatest linearity of a given tube. The close-spaced target tube generally provides greater linearity than the wide-spaced target tubes.

At each wavelength the artificial eye is substituted, and calibrated neutral-density filters are sequentially interposed. For each filter a video line is selected, which occupies approximately the same position on the photocathode as indicated by information previously obtained from the living eye.

A series of such neutral-density traces are recorded on the same film frame. Two points were chosen for examination on the line-selected trace: one corresponding to the retinal feature of interest, the other to a neighboring area of relatively uniform retinal field, serving as reference for the first point. Thus, measurements were referred to the retina itself, permitting comparison of the traces produced at each wavelength. The wavelength response ratios were modified in accordance with spectral response of the image orthicon camera tube. The result is a relative-reflectance spectrum of a specific retinal feature.

Advantages of monochromatic television ophthalmoscopy include examinations of the pigmented macular area and choroidal vessels, which are both located in regions of the visible spectrum where visual sensitivity and acuity are poor. Results are seen immediately, dynamic events can be observed, and the subject is not dismissed before all pertinent information has been obtained.

The need for an image orthicon camera chain limits the use of television ophthalmoscopy at present. The equipment is very expensive and requires specially trained personnel. However, theoretically it is possible to produce vidicon tubes with adequate sensitivity for this type of work, and they are currently being developed, according to industry sources. They would be less expensive and easier to operate, and should greatly expand work in this field.

The quantitative features of television ophthalmoscopy have not been studied enough to permit a firm statement of ultimate value, but the need for quantitative physical measurements in biology and medicine is becoming increasingly acute. Further experimentation is needed before this instrument can be used with confidence for better biochemical understanding and computer analysis. Despite the need for further testing, however, the authors believe this to be a useful new tool for ophthalmological research.

Microscopy

4.1 Barer, R., and Wardley, J. "Ultra-Violet Television Microscopy," Nature, Vol. 192, December 1961.

Published photographs of the results of coupling ultraviolet-sensitive television cameras with ultraviolet microscopes to provide an immediate image do not indicate very high sensitivity. Results from other image converters also appear disappointing. A newly developed vidicon camera tube appears promising. The special-response curve appears to be several times higher than previously reported values.

This tube has been used in conjunction with quartz objectives and condenser, illuminated with monochromatic light of wavelength 2537 A. from a low-pressure mercury lamp and simple monochromator. Excellent living cells at magnifications of 3,000 times could be displayed on a television screen. Good-quality photos of the screen have been made with a 35mm camera. Microscopy is as easy with ultraviolet as with visible light. There are no special focusing or mechanical requirements. The lenses were mounted on a simple microscope stand. Many fields of large numbers of cells can be scanned quickly, and the shallow depth of field makes it possible to focus different levels through a relatively thick specimen, thus helping to build a 3-dimensional impression.

The technique of immersion refractometry has been adapted for ultraviolet work. The lenslike behavior of an uncompressed spherical cell makes observations of internal structures difficult. This can be partly overcome by immersing such cells in a suitable protein medium that enables the structure of chromosomes to be seen clearly in undamaged cells. Actually, it is difficult to bring about reversal of contrast by immersion in protein alone. If a little nucleic acid is added to a less concentrated protein solution, it becomes possible to match the cytoplasm exactly against the surrounding medium or to make it appear bright instead of dark. This method opens up the possibility of measuring both the refractive index and absorption of living cells in the ultraviolet and also allows variation at will of the contrast of internal detail (optical dissection). This method offers considerable promise for rapid microspectrophotometry. It is simple to scan a line across the image of a cell and display a light-intensity curve on an oscilloscope screen. It is not difficult to convert such curves to an optical density scale and feed the results to an electronic integrator to measure the total mass of absorbing material.

4.2 Bushor, W.E. "Medical Electronics Part VI: Observing Life Processes," Electronics, December 1961.

Optical microscopy and microprojection have long been used, but the required illumination has often overheated the specimen. The problem is overcome by coupling television to the microscope, a procedure which also permits simultaneous and group viewing. Two integrated optical microscopic TV systems are available that produce magnifications up to the lower limits of low-priced electron microscopes, one giving magnifications up to 2,500 times with 300-line resolution, the other up to 3,500 times with 600-line resolution.

Electron microscopy gives 200 times the resolving power of compound light microscopes. The effective wavelength of the electron beam is only 1/100,000 that of visible light. Its full resolution is inhibited because electron lenses are much inferior to optical lenses. Illumination is provided by an electron beam focused with electron lens to irradiate a thinly sliced specimen. The electron image impinges on a luminescent screen or photographic film. Good electronic images can be obtained only if specimens have sufficient atomic density contrast. Tissue preparation is more exacting than required with optical instruments, and new materials and section-cutting machines are required. The main problem lies in interpretation, since the electron microscope shows only a portion of a cell and it is difficult to identify the cell itself. A major disadvantage is that the high vacuum required oxygen-starves and kills the living matter, sometimes even changing physical form before it can be viewed. Living bacteria have been photographed, however, at the French National Center for Scientific Research.

In microradiography, enlargement is necessary and optimum resolution is limited by the fineness of the film. New X-ray film developed at Stanford University gives 4 times sharper images; this should allow scientists to look at the nucleus of a cell. In projection microradiography, a geometrical blurring occurs because of an ultrafine focal spot. Electron lenses give considerable reduction in focal spot size and increased resolution. In X-ray microscopy, lack of suitable refractive material has held back development. At the University of Illinois an ultrasonic absorption microscope producing high-resolution images has been evolved that detects different acoustical absorption of biological components. This instrument should be useful in determing spatial distributions and identifying types of protein in tissue.

Ultraviolet illumination sometimes reveals previously undetected differences in the chemical and optical properties of specimens. UV eliminates staining and allows less error than light microscopes. The most important contribution of UV microscopy has been localization of nucleic acids. Extensive UV microscopy has been hindered because lenses are not apochromatic. Transmission through refractive elements is the function of wavelength, and UV light sources are not satisfactory for obtaining arc, flicker, and like outputs, and the UV image cannot be viewed directly with the eye. The UV color-translating microscope has shown promise for revealing microscopic structures in the living states. Infrared radiation penetrates some organic tissues better than visible light -- enough to differentiate cancer tissues from normal cells. No directly visible images are obtainable and photomicrography must be used. This method is well suited to analysis of minute samples of drugs, perfumes, tissues, cells, blood, and muscle fiber. In scanning microscopy, TV microscope systems use conventional scanning principles to convert the image on the target in the camera tube into electrical signals. Invisible infrared and ultraviolet images can be converted to a bright, visible picture of practically any size with a sensitive camera pickup tube. Unfortunately, the constant illumination can have detrimental effects on the specimen. Flying-spot UV scanning systems that spot-irradiate the specimen offer the highest efficiency of all UV microscopy and require relatively simple circuits. Electronic devices have made cell-counting faster, easier, and more accurate and allow quantitative measurements and counting and measuring of particles.

4.3 Evans, H. "A Microscope Lens for the Studio Camera," The NAEB Journal, March-April 1962.

A Miami television station is using a high-power, ultracompact microscope in its ETV science classes. This microscope is smaller than a home 35mm camera, is commercially manufactured, and is ideally adapted to television. With built-in source of light and automatic focusing, it requires minimum adjustment. It is screwed directly to the studio camera like a lens, moves with the camera, and operates independently of its position. It can be swung in or out of position instantly for either microscopical or normal viewing.

The author is dissatisfied with conventional microscope setups because they involve a separate vidicon pickup system and/or a rigid multiplex system with binocular and even tri-ocular configurations. This new unit measures only 4 by 2½ by 2 inches -- slightly larger with built-in light source and mercury batteries. Its prismatic system provides compactness and stable focusing, even allowing slide changes with minimum adjustment. The station unit contains three standard objective lenses, including an oil-immersion lens and standard eyepiece. It allows a power of 1,000, but the personnel prefer to use 400-power.

4.4 Flory, L.E. The Television Microscope. Paper presented to Cold Spring Harbor Symposium on Quantitative Biology, Cold Spring Harbor, N.Y., 1951.

Television, like radio, has been used primarily for entertainment, and its major potential, an extension of the human eye, has remained undeveloped. Cumbersome and expensive equipment for entertainment hindered development of television's potential in industry, science, and education. A camera can substitute for a human observer under difficult, dangerous, or restricted conditions, and can submit visual information instantaneously. As more simple and flexible equipment began to be developed, new applications, such as the television microscope, appeared. Simple and compact equipment is now available. A small, simple pickup tube, the vidicon, was developed, for example, using the photoconductivity principle rather than the photoemissive process of conventional tubes.

In the television microscope the eye of the observer is replaced by a miniature television camera. A conventional microscope illuminator is used, and ordinary optics or processes may be employed. The optical image from the microscope objective falls on the sensitive surface of the pickup tube in the camera, and is converted to a signal transmitted to the viewing unit by cable. An additional electronic magnification of 20 or more times is realized in this process.

An entire class in biology can see simultaneously a large bright image of a living organism. The instructor may point out features with an ease heretofore impossible. Researchers can now study cells at high magnification. A better understanding of cellular motions and structures has already resulted. Because picture brightness and contrast are under complete control of the operator, a narrow contrast range in the specimen can be expanded to fill the entire television system contrast range, which can be increased near the limit of resolution in the microscope. Practical utilization is possible of magnifications in excess of those normally used with the light microscope.

The vidicon pickup tubes are also sensitive to light invisible to the eye, thus allowing direct viewing under illumination from red to the far ultraviolet. Ultraviolet light allows viewing of unstained or even living specimens with high contrast. Present ultraviolet microscopes employ photographic film or plates but the image, not directly visible, has to be processed. With the television microscope one can directly observe and adjust for optimum viewing of living specimens, limited only by the killing power of the radiation (the radiation effects on organisms can also be directly observed in this manner). Quartz or reflecting optics are used in the ultraviolet equipment. An adjustable monochromatic light source for illumination is required. Any standard monochromator may be used.

4.5 Freehe, C.L. "Video Microscopy with Closed Circuit Television at the University of Washington Health Sciences Division," Journal of the Biological Photographic Association, February 1960.

The faculty had been impressed with the possibilities of closed-circuit television for demonstrations of clinical techniques when the School of Dentistry initiated it in 1951. The board of health sciences therefore appointed a television committee, under whose guidance demonstrations have increased from 8 to 235 per year in 3 years. Mobile equipment is considered responsible for the high volume of use. Controls mounted on the camera permit operation by one person, and students seem to gain more from demonstration originating right in front of them in the lab or classroom than from a remote studio with 2-way communication.

A standard broadcast camera chain was purchased, together with 21-inch monitors. A second camera chain has since been added. For microscopy, one camera has been mounted on a mobile stand on an 18-inch vertical adjustable column with the tripod plate attached to the camera base to allow horizontal movement. Only the 2-inch lens is mounted on the camera, with a double-acting prism attached for viewing illustrations. By rotating the turret 180°, a 45° prism and tube come into play, 1/8 inch from the top of the ocular of a microscope. This microscope had the advantage of built-in illuminator and a focusing stage rather than focusing objectives. A fine hair inside the lower element acts as a fixed pointer for the low to medium magnifications. Standard photographic oculars and homals are used. The image is projected from the ocular through the prism to the face of the vidicon tube (the camera is mounted horizontally). With the camera chain adjusted for 600-line resolution, image quality is good and each student can be certain that what the instructor is discussing is what he is observing through his own microscope.

Indications from faculty and students alike suggest that the University of Washington will schedule an even greater number of such demonstrations next quarter than the 14 scheduled this past spring.

4.6 Land, E.H., Blout, E.R., Grey, D.S., Flower, M.S., Husek, H., Jones, R.C., Matz, C.H., and Merrill, D.P. "A Color Translating Ultraviolet Microscope," Science, Vol. 109, April 1949.

Monochromatic ultraviolet microscope objectives, used with film, marked an important advance in seeing very small structures in spectral regions where human eyes are not sensitive. Plant and animal tissues have been examined effectively because absorption of biological materials in the ultraviolet region allows photography without dyes or stains, and shorter-incident radiation wavelengths allow about twice the resolving power of visible light.

The authors are developing a system of ultraviolet microscopy that uses, simultaneously or sequentially, three different ultraviolet wavelengths, which when combined with three primary additive colors and superimposed, produce a visible image in full color. The authors considered other wavelength translations, such a fluorescent screens, but decided that an instrument using photographic techniques would be preferable in sensitivity, availability, and retention of a permanent record.

The instrument employs a superhigh-pressure, water-cooled mercury arc, grating monochromator, microscope, apochromatic objective and identical lenses as condensers, camera with 35mm motion picture film, film processing station, 3-beam projector, and viewing screen. The mercury arc was found to be the brightest available light source. Proper exposure will be achieved by an automatic photoelectric exposure control device now under construction. Settings for monochromator wavelength are made reproducible by micrometer-controlled stops and bandwidth controlled by slit size. The objective and condenser are apochromatic over the 220-800$m\mu$ wavelength range, enabling the microscope to be focused for ultraviolet light by focusing it with visible light. The camera frames must be indexed with extreme accuracy so that subsequent triple projection is in register. About 400 feet of 35mm film can be used in one loading. After exposure, the film is automatically processed and is ready for projection within 10 seconds. It has a developed area of 0.7 inches. After development and fixation of the negative image, the film is moved to a projector where three images, taken successively at three different ultraviolet bands, are projected simultaneously through three additive color filters (red, green, and blue) upon a 4½ inch circular translucent plastic-in-plastic screen. The 8X magnification produces a reasonably sharp and bright image.

Maximum color contrast is possible since there are no natural colors, and three ultraviolet bands plus three visible colors provide six possible combinations of images and filters. In addition, there is the possibility of processing the ultraviolet image to yield a positive rather than a negative. The special plastic-in-plastic screen gives maximum screen brilliance, evenness of illumination, and definition. The device is called a color translating microscope, rather than a micrograph, because the manipulative operations involved and the general time requirements are similar to those involved in ordinary visual microscopy.

4.7 Zworykin, K.A., *and* Chapman, G.B. "Television Microscopy of Sporulation and Spore Germination of Bacillus Cereus," *Journal of Cellular and Comparative Physiology*, Vol. 48, 1956, pp. 301-16.

The A.T.C.C. (American Type Culture Collection) strain number 7064 of *Bacillus cereus* was sealed into an agar, properly hollowed, onto the top glass of a constant temperature slide. The slide was placed on the stage of a light microscope, and the specimen was studied with a 90X, 2mm numerical aperture 1.30, apochromatic, oil-immersed objective and a 7.5X compensating ocular. Illumination was provided by a microscope illuminator. The light was passed through distilled water but no other filters were used. A vidicon television camera was used, mounted over the microscope ocular and cable-connected to a monitor and control unit. Permanent records of the images were obtained by photographing the screen.

The use of the television microscope in studying living bacteria led to the observation of two heretofore undescribed phenomena: the sudden and forceful expulsion of spores from sporangia and a "dedifferentiation" of nearly mature spores. Prominent cytoplasmic inclusions, principally lipoid, have been observed, but did not become incorporated into the developing spore. Upon disintegration of the sporangium, they persisted independently in the medium. Spores were observed to occupy every possible combination of terminal positions in neighboring sporangia. The method was found particularly useful for long-term, continuous studies of living cells, especially where contrast enhancement is desirable.

4.8 Zworykin, V.K., *and* Hatke, F.L. "Ultraviolet Television Color-Translating Microscope," *Science*, Vol. 126, No. 3278, October 1957.

The recognition of cell structure and tissue specimens is greatly facilitated by ultraviolet illumination. Ultraviolet microscopy has suffered because of the need for photographic exposure and development to render the image visible. The ultraviolet television microscope now permits immediate observation of the specimen. This idea became practical for photography through development of catadioptric microscope objects, which are apochromatic over the entire range of the ultraviolet and visible spectrum. With these objectives it was possible to construct a photographic color-translating microscope that gave excellent color pictures of biological specimens under ultraviolet illumination. Another similar color-translating ultraviolet microscope needs only 25 seconds for processing and minimizes delay between exposure and examination of the picture. The photographic method obtains good results but does not allow the scanning of large quantities of material at high speed. This microscope system allows examination of specimens in the ultraviolet with the same speed and simplicity as examination in the visual range. A permanent record is obtainable by color photography of the receiver screen.

Sequential illumination is preferable to "white," unseparated ultraviolet radiation. The experimental ultraviolet-sensitive vidicon employing a photoconductive layer of amorphous selenium has been developed specifically for research, but it exhibits a lag, causing afterimages of rapidly decreasing intensity. Wherever freedom from lag and very high sensitivity are essential, it is better to employ a camera tube such as the image orthicon in spite of higher cost and more complex equipment. The illumination system of the color-translating microscope may employ either a single-light or 3-light source, and the camera may operate on the field-sequential principle, with a single camera tube, or on the simultaneous principle of three camera tubes in parallel.

Many drawbacks were overcome in a television color-translating microscope constructed at the Rockefeller Institute for Medical Research. Separate light sources allow selection for high emission in particular wavelength ranges. Timing control is provided by a commutator sector mounted on a rotating stage. Living materials at high magnifications can be studied without artifacts from chemical change. This may be one of this instrument's primary advantages. Protracted studies have revealed no visible structural changes resulting from ultraviolet irradiation. Cell preparations frequently reveal fine details that are not visible with illumination by visible light. Pigments present in too small concentrations to impart appreciable coloration to a specimen give rise to striking color contrasts in the ultraviolet. Knowing the absorption coefficients of the materials, one can even obtain quantitative estimates of their concentrations at any point of the specimen. For this purpose the authors employ a line-selector oscilloscope to select a particular horizontal scanning line and represent the variation of the video signal along it in the red, blue, and green channels on separate cathode-ray tubes. Because practically any chemical differences can be translated into color differences with this instrument, it is a valuable tool in the rapid diagnosis of any disease whose onset is characterized by intracellular chemical changes.

Postgraduate Education

5.1 Brown, M. "Television as a Tool in Postgraduate and Undergraduate Medical Education," New York State Journal of Medicine, Vol. 60, No. 6, March 1960.

Television has become part of our everyday lives, and educators, among others, must face the changes it brings. Dr. Abraham Flexner's goals for undergraduate medical education, proposed in 1911, have yet to be fully attained, and postgraduate medical education remains largely a random responsibility. To solve the "crisis in education" today, modern technology should be explored. Leadership combining understanding of education and technology is sorely needed.

Recent studies have shown television to be very effective as a teaching medium, but its more effective use demands technical skills. Currently, teachers must either yield to skilled television personnel, thereby losing control of the teaching situation, or try to master the technology. The status of the teacher is not improved by the implied threat of replacement by an electronic device. The issue of control of the teaching situation is a real one -- and some teachers already refuse further participation against the tyranny of the televised situation.

Two families of instruments could improve the situation: one, a group of all-purpose camera and equipment, flexible, cheap, simple, easy to operate, greatly light-sensitive, and lightweight; the other, a group of special instruments, such as a television ophthalmoscope and a color microscope, again cheap, simple, and easy to operate. Many technical and presentation problems are already being mastered by teachers. Physiology and laboratory experiments, demonstrations of unseen phenomena using ultraviolet and infrared systems, and living vascular structures can be presented. Tremendously magnified color pictures of the retina can be recorded through television. We can present living physiology studies by means of "line selection" that allow students to estimate structural measurement changes. Television is not yet completely functional in the operating room, but an operating room is currently under design to minimize the current problems.

Thus the problem of usable equipment is not so much an electronic as an economic one. Traditionally impoverished educational institutions cannot afford the current price. One hope for lower prices lies in expansion of the market to include the research field, which uses many of the same devices. Another is the small, creative company seeking new business. Such a company might be influenced to produce a 1-control color microscope costing from $3,000 to $5,000 to replace the scopicon in teaching from specimen slides. It would have to have true color, high magnifications (oil immersion), complete linearity, ease of operation, simplicity of design, and resistance to tampering. A black-and-white television ophthalmoscope would be tremendously valuable. Students and teacher could then view the same retina simultaneously. A working model has been developed for $20,000, plus $6,000 annual maintenance. We should be able to get a better instrument for $1,000 that would require only occasional maintenance. Simple modifications on radiological devices should be made to show fine detail.

Existing television techniques are more easily adapted by postgraduate education, since they coincide with certain factors in the physician's education. About 25 percent of the country's doctors are highly motivated to continue lifelong professional education. Our concern is with the remaining 75 percent. General practitioners lose touch with recent developments within 6 years of leaving school, specialists after about 11 years of practice. Television can reach these men, through open-circuit broadcasts during odd hours; scrambled, special-channel, or private broadcasts; and closed-circuit broadcasts. Kinescopes and videotapes can be used over and over in a variety of ways. If high standards were maintained, the need is such that money would be found to support such education. Social pressures and economic rewards should provide sufficient motivation to insure the success of such programing.

5.2 Darley, W., and Cain, A.S. "A Proposal for a National Academy of Continuing Medical Education," Journal of Medical Education, Vol. 36, No. 1, January 1961.

Pressures of time and work make it difficult for the practicing physician to maintain scientific understanding, critical judgment, and professional competence against the factors of time and advancing knowledge. Until 50 years ago clinical practice defined the physician's educational research processes, but now the constantly accelerating expansion of medical-scientific knowledge steadily alters concepts of professional practice. There is little practical way for physicians to keep up-to-date. Remedial efforts have been made through professional groups, journals, meetings, and courses, but there is no integrated, uniformly high-standard educational program to meet the physician's mounting educational requirements.

With these thoughts in mind, the establishment of a "National Academy of Continuing Medical Education" is proposed. It should not be difficult to utilize the wisdom and experience of outstanding, academically free, able, and dedicated physician-scientists to develop definite programs to meet the educational requirements of the practicing physician.

Effective and convenient transmission could be supplied by well-tested film, TV, and radio educational techniques, and other facilities that have already been used effectively for higher education. These media could be supplemented by printed materials, 2-way telephone, and mail question-and-answer methods, which have been used successfully in other fields. In the authors' view, television (both open-and closed-circuit) should play its role only under the aegis of a national agency such as they are suggesting. Its potential should not be obscured by the commercial abuses it has suffered. Foreseeable technical developments forecast its unlimited use; geographical remoteness can be overcome; it is bound to stimulate better teaching because programs can be revised constantly with increasingly critical appraisal from the practicing physician.

Major elements in the Academy's effectiveness would depend on its board of governors and their relation to a full-time administrative staff, as well as financial considerations. A board representing all logically concerned professional agencies with final authority for a National program of continuing education would provide the Academy with the status, scope of opportunity, and freedom of action to do what no one agency can do alone. The administrative staff would be full-time but not necessarily directly involved in teaching. Its role would be selection and development of subjects, programs, lectures, study methods, and the necessary follow-up and adjustments. If it fulfilled its function well, there would be no doubt in the individual physician's mind that he had gained a real dividend from his investment of time and effort.

Funds in the early phases should come from the cooperating professional agencies in order to insure planning independence, but when plans actually are underway, there would be a strong case for support from private foundations, voluntary health organizations, and if without strings, industrial sources. Aid might be obtained from various bureaus of the U. S. Department of Health, Education, and Welfare. Educational service to the individual practicing physician and his local hospital, society, and voluntary health groups should attract major support.

The proposed Academy should not compete with existing, physician-controlled educational media, but rather, should function with a high-level, graduate school philosophy; it should fill a void rather than replace a process. It would serve as a liaison and reinforcement of local, regional, and national group efforts. Difficulty in transmitting knowledge of research and usage of drugs would be abated. Standardization of terminology and standards of accuracy would be developed to serve all levels of eduational activity in medicine. The present gap between what is needed and what is being done is comparable to the situation in undergraduate medical education in the early 1900's.

5.3 Elsom, K.A., and Roll, G.F. "Color Television as a New Medical-Teaching Aid," Journal of the American Medical Association, Vol. 147, December 1951.

Medicine was the first of the sciences to benefit from color television as a teaching aid. An adaptation of commercial field-sequential color television consisted of a camera, control and audio components, and 20 receivers. The camera was mounted on a dolly-boom and was sparkproof. Transmission included closed-circuit microwave or coaxial cable relay up to a distance of 40 miles.

Ordinary operating room lights generally suffice for surgery, with diffusion provided by two portable banks of fluorescents. The camera, audio, and control panel each need one technician, and the 20 receivers need three: two to adjust them and one to monitor the incoming signal. A physician is needed to plan, direct the camera-man, and coordinate the program during the telecast. A floor manager, who works with the physician, gives preliminary instructions to speakers, moves props, adjusts microphones, etc.

For teaching operative surgery, television demands few changes in procedure. Camera placement and landmarks must be indicated verbally because of the small visual field. The surgeon must speak in normal tones to his team and to the audience, since the microphone picks up every sound. Pathological specimens should be put on a towel over the incision and displayed immediately in order to avoid moving the camera away from the lights. Only procedures essential to teaching should be shown; the operation should be worked up before the demonstration; and closure of the wound should be done off camera. Five major operative procedures can thus be presented within a 3-hour program.

Effective presentation of a medical clinic requires material that lends itself to pictorial presentation. TV is no place for didactic lectures, and audiences feel no compulsion to watch uninteresting speakers. Clinics presenting patients or unusual subjects are most successful. Visual material normally used in lectures is frequently inappropriate for TV, as what is shown must be large, simple, and free in use of color. Mannerisms are out-of-place on TV. The speaker must stand still to remain in focus, and look into the camera lens.

The postconference survey of 116 doctors indicated that 91 percent preferred the color TV demonstration to the amphitheater and that 52 percent preferred it to being at the operating table. After a 2-day postgraduate seminar at Wayne State using color TV, a survey in which 350 of 500 conferees responded, showed that 96 percent preferred color-televised surgery to the amphitheater and that 85 percent preferred TV clinical presentation to conventional papers read from the platform. Forty-two percent considered diagnosis the subject of greatest interest, 38 percent treatment, and 20 percent the new advances in research.

Future use of television for teaching requires development of new techniques and adaptations to informal undergraduate teaching. Scrambled images could provide postgraduate training to the doctor in his home or office.

5.4 Galdston, I. "What Have Radio and Television To Contribute to Continuation Medical Education?" Journal of Medical Education, Vol. 29, No. 4, April 1954.

Many educators have not yet realized that the radio and television media are more than mere means of sound-reproduction or duplications of an original message. The writer, who has had extensive experience with radio and motion pictures, feels that, except for a few isolated instances, neither medium has been used toward effective education. No analysis of their educative assets and liabilities has been made.

One question to be answered is whether a radio or television speaker should address himself to the listener or to the subject itself. Effective communication to a person involves such psychological factors as arousing curiosity and enlisting sympathy. Dedication to a subject alone requires only adequate knowledge and competent organization of that subject. The medical man almost invariably addresses himself to his subject -- be it heart disease, diabetes, or cancer -- not to his listener.

Other questions to be explored involve understanding of what the eye and ear perceive, the span of listener attention and perception, and of what audience is to be reached. Radio is a medium of the spoken word and television is a medium of motion. How much medical education requires motion? In educational television, which feature should predominate -- sight or sound? Should the picture illustrate the text or the text illustrate the picture? Until we do ask, and find answers to, these and other questions, we are not likely to do any better with television than we have with radio.

5.5 Tribe, H.E. "Newer Audio-Visual Methods in Use at the University of Utah," Journal of the Biological Photographic Association, Vol. 25, Nos. 1 and 2, February-May 1957.

Five States adjacent to Utah have no medical schools, but limited facilities prohibit the University of Utah Medical School from accepting more than 10 percent nonresident undergraduates. It can, however, provide postgraduate training and has long done so, providing 3- to 5-day courses, plus evening programs, guest lecturers, and visiting professors. Because the participating physicians in these general programs are forced to leave their practices and travel long distances to the university center, an attempt was made to carry the program to the doctor in his community.

A series of rural seminars was successfully operated from a station wagon filled with audiovisual aids (models and charts, etc.), but this proved expensive. Television clinics have also been tried with some success. Evaluations following each of two series of telecasts indicated that learning took place, that doctors accepted this type of instruction, and that there were no iatrogenic side effects. Subsequent evaluation of kinescopes of the second series that were viewed in 43 locations throughout the Nation indicates uniform acceptance.

A program is being maintained and expanded to provide Utah physicians with "Audio-Visual Seminar Kits" containing a medical discussion on an LP record, a script, color slides, and a table viewer. Out-of-State users are charged $5.00 in addition to freight. As an outgrowth of this program, other organizations are using this idea.

The authors have borrowed from their placement office a communication technique that employs color slides and commentary on tape which is keyed to change the slide machine. This technique should be useful to hospitals for recruiting interns, nurses, and other personnel, and to medical schools for recruiting students. The authors have used the tape for teaching self-care to such patients as diabetics. The same slides can be used with several different presentations for different ends. Utah plans to use a tape of this type for psychological testing to standardize time and facts. A script is almost a must for effective use of this method, and color slides are recommended.

5.6 Warner, R.S. "New Audio-Visual Methods in Postgraduate Medical Education," Journal of the Biological Photographic Association, Vol. 22, No. 4, November 1954.

The University of Utah College of Medicine has attempted to provide a program of postgraduate education for the scattered physician population of the intermountain West by sponsoring short courses at the school and conducting rural seminars. School attendance requires the physician to travel great distances and leave a busy practice unattended, and rural seminars are expensive and require all participants to travel. Two new methods were devised for meeting this problem: (1) the "Audio-Visual Seminar Kit," which consists of 33-1/3 rpm records, slides, viewer and script of the discussion and which allows the physician to study at home or in the office. The kits proved so successful that they were released throughout the United States, Canada, and Mexico (for a minimal charge and freight costs). Most users thought the kit had definite educational value. (2) Regular open-circuit television was another effective way to reach a large number of physicians. Accordingly, a series of four medical clinics were designed at Utah for TV and were televised directly from the Salt Lake General Hospital at 7 a.m. Tuesday mornings. Physicians in the reception area -- over a 150-mile radius -- were sent advance notice but there was no public announcement. The first clinic, dealing with congenital heart disease, used printed charts, X-rays, and an electron electrocardioscope. X-ray films were found to be one of the most suitable visual aids for medical television.

Each of the 700 physicians within the reception area received questionnaires, and upon completion of the series, was interviewed by telephone about his reaction to the idea and to the various phases of the program. The total viewing audience was larger than attendance at the postgraduate course in the school itself.

Because of the enthusiastic reception of the clinics, a second series was kinescoped and presented, and was later made available to other medical groups and TV stations. Some techniques were improved. A telephone and mail survey again followed the 4-program series. There was found to be a decrease in viewers, probably because the novelty had worn off, and also because many physicians were on vacation. Physicians outside Salt Lake County, who had no immediate access to medical school facilities, composed the greater part of the audience, and general practitioners viewed the telecasts more frequently than specialists, as in the first series. A content quiz, given both to listeners and non-listeners, indicated that viewers gained new medical facts and that these clinics have a definite educational value. Evaluation of the kinescopes (now on loan) is being conducted.

Instead of the usual kinescope apparatus, equipment for making the film copies at the hospital from the live telecasts consisted of a camera with a TVT shutter (a camera geared to the TV norm of 30 frames per second rather than the film norm of 16 frames per second).

5.7 Warner, R.S., and Bowers, J.Z. "Program of Postgraduate Medical Education," Journal of the American Medical Association, April 14, 1956.

The American Medical Association's Council on Medical Education and Hospitals has emphasized the importance of postgraduate education as an integral part of medical education. Some medical schools have begun programs to bring pertinent new information to busy practitioners, which they can apply to their everyday medical problems. The University of Utah College of Medicine worked, with the help of a grant, to seek new media and improve existing programs. Three- to five-day courses were designed with primary emphasis on practical aspects of diagnosis and treatment. Courses on heart disease, especially electrocardiography, were most enthusiastically received. An 8-week evening course on the legal implications in the practice of medicine was also especially well received. A subsequent survey indicated that the participating physicians preferred intramural courses and television clinics to other teaching methods.

Busy practitioners in far-flung communities are often unable to leave their practices for a course at a medical center. A program offering an afternoon and evening of clinical education was instituted in a more convenient location. One method of meeting the desired goal of postgraduate medical education with minimal loss of practice hours was the use of a traveling station wagon equipped with teaching devices. An "Audio-visual Seminar Kit" succeeded in providing interested doctors with a convenient and comfortable educational method. It consisted of a recorded medical discussion, a set of 35mm related slides with viewer, and a script of the discussion. The doctor supplied his own long-playing phonograph.

In 1953 the University of Utah College of Medicine televised a series of medical clinics, for physicians only, from Salt Lake City General Hospital. Four clinics were presented at weekly intervals Tuesday morning from 7 to 8 on an open-circuit commercial station. Doctors' reactions were checked by phone, and it was found that 49 percent had seen at least 1 program; 74 percent of the viewers felt they had gained some new facts; and fewer than 5 percent objected to the use of open-circuit television for medical education. A check of the degree of public viewing revealed that about 1 percent viewed the programs and none made adverse comments.

In recognition of the potential of this type of postgraduate education, a second series was televised. In addition to a careful evaluation of audience reaction, an attempt was made to determine whether a doctor could increase his medical knowledge this way. Early morning telecasts were again presented and kinescopes were made for distribution to other areas of the Nation. Telephone interviews and mail questionnaires revealed that doctors in the rural areas accounted for the greatest percentage of the audience (the audience represented 31 percent of the doctors in the intermountain area). Viewers and non-viewers alike were asked to answer questionnaires. In three out of four clinics the viewing physician was able to supply 20 to 25 percent more correct answers than the non-viewing one. These results confirmed the impression that doctors can gain new medical knowledge through the audiovisual medium of television.

Psychiatry

6.1 Holmes, D. "Closed Circuit Television in Teaching Psychiatry," University of Michigan Medical Bulletin, Vol. 27, No. 6, Nov-Dec 1961.

Although closed-circuit television is not likely to revolutionize the teaching of psychiatry, it has proven an extremely useful addition to standard methods. Some initial misgivings did not materialize but neither were several chronic teaching problems solved. In 1958 the first live-case presentations began via closed-circuit television in junior-year lectures on organic brain syndromes. Student and teacher responses were favorable and the program was expanded to other subjects.

Selected patient interviews by a staff member in the main hospital studio are transmitted to a large auditorium where 180 medical students and a lecturer watch. Communication with the interviewer is maintained by a simple intercommunication system. Case presentations of 15 to 20 minutes are preceded or followed by a straight lecture, general class discussion, or both. The most obvious advantage of television is "close-up" observation by many students simultaneously. Students can watch one teacher apply relatively abstract terminology and systems of thought to one patient in one situation. Presentation of a "current" patient lends immediacy and credibility far exceeding movies or tape. The visible and audible presence of the patient imparts a personal realization of responsibility for the case, as opposed the reaction to a filmed patient who has been "examined, diagnosed and treated" by unknown numbers of medical students. Also important is the student's need to observe something on his own and note a reasonable diagnostic possibility or treatment recommendation that no one, including the professor, may have seen.

In medicine generally, dealing in person with a live patient provides a sense of immediacy, but limits the instructor's commentary and the student's participation. This is especially true with the psychiatric patient. Closed-circuit television permits active classroom discussion without the risk of a student "saying something wrong." An unlooked-for advantage has been the fact that many patients do not respond with the "classic syndrome" with which the lecturer had hoped to illustrate a point. He must then answer the challenge of the real clinical circumstance and students profit from the greater clarity thus demanded of the teacher. One of the greatest difficulties in teaching psychiatry, the student's tendency to deny the existence of even the most gross forms of mental illness, is overcome by the intercommunication system between lecturer and interviewer, which draws attention to subtle but highly significant clinical findings while they are actually occurring.

Television also permits greater teaching economy without undue sacrifice of respect for the patient's comfort. It seems that appearing before a television camera is not as stressful for a patient as a stage appearance before a large audience. Closed-circuit television also offers effective prophylaxis against the academic rarefaction of large teaching sessions. Prior to the use of television, there was some concern that its use might aggravate certain of the patient's pathological tendencies. To date, there has been no recognizable evidence of this, even when extremely paranoid patients have been presented. This fear was not well justified, even theoretically, because a patient becomes delusional as protection from threatening pressures arising within himself. If television is for him an object upon which to project this personal threat, then he will probably use it. Television might therefore contribute to the content of the delusions but it is highly unlikely to create a new need for them.

A more valid problem exists with a patient's reactions to his selection for TV. The patient wonders if he is deemed more sick or less sick than most patients if he is specially favored by his doctor or if he simply has such a limited prognosis that it doesn't matter what is done. The answers to such questions may be affirmative and it is essential that they be recognized and considered with the patient if the experience is to be beneficial to him. Another pitfall lies in the possibility that students may assume that the interview is meant to be sensational or inspirational. Short quizzes on matters of simple observation help to maintain their focus on the primary task of careful and thoughtful observation.

The belief that the psychiatric patient is a person with problems rather than a mental case tends to be honored intellectually rather than really understood. Many of the methods required in treatment tend to confirm the "mental case" self-image of the patient himself. Whether this influence is favorable or damaging will depend crucially on the professional behavior and attitudes toward him in any shared experience. One cannot reassure a patient effectively against such fears and then distort, avoid, or gloss over questions he is bound to have about this unusually formal and impressive experience. Given the attitude that he has the right to know what is going on and that this is compatible with treatment aims, the patient is asked if he would consent to being interviewed on closed-circuit television, and he is given a brief but entirely accurate description of the size and kind of audience and their reasons for observing the interview.

Physical arrangements should be described -- the presence of camera, bright lights, studio crew, cable transmission, and communication between interviewer and lecturer. The teaching importance should be emphasized but it must be very clear that the patient's welfare is of first importance. He should be made to feel free to decline the request without apology. He is also entitled to his own doctor's frank opinion about the matter. He should be advised in advance about the general direction of the interview and consulted about any area he wishes to avoid. Potentially embarrassing information of a private and personal nature is usually inappropriate to the situation. Even if he initiates such discussion, the interviewer must exercise careful judgment about continuing it. If the interviewer receives an inquiry from the classroom during the session he should inform the patient. This approach must be used with every patient, from a small child to an extremely psychotic patient.

There are unquestionably other uses, some good, some impractical or improper, to which television can be put. In time, the television medium may relieve the academic psychiatrist from the strain of perpetuating the fiction that he knows just how a patient should be interviewed. It is no accident that all of these interviews to date have been done by relatively junior staff members. Television should be of value in making didactic discussions of personality growth and development more real and credible. Joint presentation of patients in conjunction with other medical specialists is also an attractive possibility. From the practical standpoint it would not be difficult to demonstrate some of the somatic treatments but in all probability there will be little occasion to do so. It seems inconceivable that office psychotherapy could be demonstrated in anything resembling its actual form. A high degree of privacy and confidentiality are two conditions important to psychotherapy; nor can television ever be used for secret transmission of any sort. As a frank invasion of the patient's privacy, such an action would be unethical as well as illegal. The most obvious and important point is that the medium can never be substituted for firsthand experience with the patient.

6.2 Michaux, M.H., Cohen, M.J., *and* Kurland, A.A. "Closed Circuit Television in the Scientific Measurement of Psychopathology," *Medical and Biological Illustration*, 1962.

In psychiatric research it is always difficult to measure precisely a patient's symptomatology or degree of illness. Although several frequently used rating scales have been standardized carefully for reliability and validity, the concepts are frequently, of necessity, intangible. Closed-circuit television was used at Spring Grove (Md.) State Hospital in seminars devoted to development, modification, and standardization of psychiatric measuring devices.

Equipment used consisted of a camera with 4-turret lenses, a concealed 1-way mirror, intercom among observers and interviewer via earphone (hearing aid) apparatus, turret selection and focusing device performed remotely by observers, and concealed microphones transmitting sound to observers. Equipment and installation (including two other single-lens cameras) cost about $12,000. Operation and maintenance were handled by the medical staff. The rater-training seminars were conducted in conjunction with a 9-hospital cooperative study of the effectiveness of certain tranquilizers in the treatment of acute schizophrenic patients. It was extremely important for investigators to be in substantial agreement in their interpretations of criterion rating scales. Two Spring Grove research staff members conducted a patient interview simultaneously before the camera, and subsequent evaluation was conducted independently by each of the nine station investigators, after which there were detailed discussions of findings.

The success of this technique led to its use by the Veterans Administration, where a continuing program of interhospital cooperative research is in progress. Typescripts, tape recordings, 1-way screens, and staff conferences had been tried previously and discarded as a means of securing simultaneous ratings from a number of clinicians. Logistically, the ideal interview method is one that does not inhibit the patient by outsiders' presence, does not cramp the interviewer by constant awareness of being on display, and does not decree that raters must sit motionless, smokeless, and mute during the interview. Television meets these criteria.

Patients seemed unaffected by being on camera (they were informed beforehand). Observers were able to relax in a lighted room, interact among themselves, ask for clarifications, shift in emphasis by speaking to the interviewer via his "hearing aid," and change their view of the patient by changing lenses at will. Seminar participants differed sharply, both in interpretations and in reaction to the mechanical setup, but as seminars progressed, ratings tended toward greater agreement. The smaller observer group (12) seemed much more conducive to observer interaction. Affluence of home institution was seen as a possible reason for differences in viewpoints. Participants unanimously stressed the need for mutual agreement on meanings of concepts used in measuring. Television was considered the best solution now available to the logistics problems inherent in group observation of patients.

The raters felt that they reached better agreement about scale items and interpretations of patient behavior. Relaxation was possible to an extend inconceivable in any other observation technique. Thus, optimum conditions for rater training, construct validation, and scale development were provided.

6.3 Moore, F.J.,M.D., Hanes, L.C., M.D., and Harrison, C.A. Department of Psychiatry, University of Mississippi Medical Center, Jackson, Miss. "Improved Television, Stereo, and the Two-Person Interview," The Journal of Medical Education, Vol. 36, No. 2, February 1961.

The University Medical School is experimenting in televised psychiatric interviews using three television cameras to provide three distinct shots on 21-inch monitors in the classroom, a close-up of the patient and psychiatrist, and an overall view of the scene. Further reality is gained by the use of stereophonic sound.

The psychiatric student has little opportunity to work with patients. He cannot sit in as an observer because he would disturb the balance necessary to the 2-person psychiatric interview. Yet it is essential to his learning that he observe patients' facial expressions, voice tone and quality, body attitudes, and other signs, in addition to the verbal content of the interview itself, which will provide him with the ability to interpret objectively and to perfect his own communication techniques.

Since 1957, students have observed patients through 1-way glass, using an audio system. This method limited the size of a student group. The new system places TV cameras behind the 1-way glass and allows an entire class to observe an interview and then hear a discussion of it by the staff. The equipment requires only one operator, since no "programing" is done unless the interviewing psychiatrist wishes to use film and make minor editing changes to protect the patient. It is hoped that when filming becomes more simplified, the psychiatrist can use it to gain more insight into the strengths and weaknesses of his own technique.

To the inevitable question of the ethics of recording and televising psychiatric interviews, it is pointed out that only physicians, medical students, nurses, and nursing students view the program on closed-circuit television and that these are the same people with access to hospital records. If they can be trusted with confidential records, they should be responsible and objective enough to observe televised interviews. Others think that when participants know they are being televised they tend to become stilted. To some extent this is true, but it is believed that the people involved forget all about it when the novelty wears off.

6.4 Ruhe, D.S., Gundle, S., Laybourne, P.C., Forman, L.H., Jacobs, M., and Eaton, M.T. "Television in the Teaching of Psychiatry -- Report of Four Years' Preliminary Development," The Journal of Medical Education, Vol. 35, No. 10, pp. 916-27, October 1960.

Television has been used for 20 years for research, documentation, and professional teaching. Its benefits have extended to public broadcasts of psychological subjects, both real and fictional, and courses in psychology and other behavioral sciences successfully presented on and off campus -- a 10-year span of closed-circuit professional presentations at medical conventions and postgraduate education of physicians in psychiatry. Its use in medical centers has been slowed by organizational complexities, but a recent survey revealed beginnings of television exploration in relation to its psychiatric potential in such universities as Washington, Michigan, Western Reserve, Albert Einstein, Wayne State, and Pennsylvania Psychiatric Institute. In 1956, Kansas University Medical Center explored the idea of integrating television into its curriculum, after having used it intermittently since 1949.

A freshman course, Introduction to Psychiatry, utilized three or four 1-hour televised presentations of unrehearsed interviews to illustrate manifestations of conflict and anxiety, ego-defense mechanisms, unconscious processes, and uses and results of hypnosis. Televised demonstrations of newborn infants were also used to illustrate variation and complexity of human beings at birth. A discussion by the lecturer followed each demonstration. In the sophomore year, introductory courses in psychopathology illustrated the dynamics of various symptoms of emotional illness. These psychiatric interviews were greeted so enthusiastically by students and faculty that the course, which had previously used motion picture demonstrations, incorporated sizable televised portions. Some programs were canceled because of inappropriate or resistant patients. Senior students, who spend a day weekly for 8 weeks with out-patients, supplemented their education by televised observations of out-patients being diagnosed or processed for intake. Discussion with the therapist followed observation. Twenty-nine such interviews occurred in 1958-59 (but were temporarily discontinued in '59-60 because of curriculum reorganization).

The televised observation method replaced the use of 1-way mirror, in which students were hampered by physical shortcomings of the observation room and entry by sections at long intervals into case progress. Residents enrolled in Training in Psychotherapy interviewed patients under the eye of television camera and microphone. The action was transmitted to fellow residents and staff members and supervised by a senior faculty member, who gave interpretative comments during the interview and conducted group discussions of content and method afterward. Tape recordings of voices were sometimes made for the resident therapists' convenience, but filmed record of the television image was considered valueless. Noncurriculum uses of television have included freshman orientation, clinical interviews, and a faculty consultation with a resident to expose attitudes and available knowledge, thus highlighting the process of learning and maturation in medical education.

Color television is unessential in psychiatry. Broadcast standards are not required, and local needs guide the choice of monochrome systems. A vidicon-tube camera is standard for every fundamental, technical, and educational reason. Many makes are available, and are being engineered toward smaller size, more automatic function, and lower cost. There is a nonbroadcast camera with a 3-lens turret, equipped with a high-sensitive vidicon tube, which supplies an acceptable 400-line picture. The interview must be televised through 1-way mirror in order not to disrupt the essential patient-doctor privacy, but present vidicon tubes cannot combat the light losses imposed by this method even when excessive light and heat are supplied in the interview room. Therefore, a clear glass port was cut through the decoy bookcase. Camera and lenses were masked and lens edges blackened. The camera room was darkened so the television process could not be seen. While additional overhead fluorescent lighting was adequate, far more sensitive tubes are still needed for improved viewing. Wall-to-wall carpeting and wall curtains reduced reverberation. The patient was seated facing the camera almost head-on, while the psychiatrist was seen in profile or over-the-shoulder, to minimize both his personality and presence. Occasionally, both were side-by-side. Simplicity, light colors, and low contrast were keynotes for the setting. Audio pickup is volumetrically more important than visuals, even though personalities give reality and meaning to words. A microphone was concealed in a telephone. Participants newly orienting to this method paid undue attention to audio limitations, but it was too expensive and complicated to control great voice contrasts or clarity of speech. It was easiest and cheapest to utilize standard television receivers on 60-inch-high classroom stands. A classroom instructor controlled the picture quality and the level of audio without guidance. Large images were psychologically important in auditoriums because of subconscious comparison to motion pictures. In the 900-seat major auditorium, field-sequential color television projectors were utilized during experiments with the orthicon camera of the same system. Recent use has been made of a black-and-white projector. When a small conference room, major auditorium, and large classroom were equipped with permanent coaxial cables, setup of equipment became minimal. However, until sensible television utilization has been established in any medical center, only temporary coaxial cables are recommended.

Starting equipment for a good 1-lens, automatic vidicon camera with a 17-inch video monitor would cost about $1,500. For best all-purpose function -- a camera supplied with high-sensitive vidicon, 4-lens (zoom lens suggested) remote-controlled turret, and control monitor -- the cost would be about $3,000, complete with carrier equipment. Small, all-transistorized new cameras combine easy handling with a broadcast-quality picture, and cost about $4,500 without accessories. A portable studio vidicon camera complex costs about $12,000.

Other demonstration methods have been tried. Patients have been interviewed in an amphitheater, but teacher-patient interaction was not clearly visible and the limitations of the patients themselves hindered the learning process. The 1-way-mirror method permitted students to observe personal factors, but was again limiting. It allowed only small groups. Students could not discuss the case without being heard by the patients, and were hampered by darkness and poor ventilation. Television demonstrations permit any size group, at any distance, to observe patients in detail, simultaneously maintaining interview privacy. The only limitations are ethical ones. Filming televised interviews is not yet practical. Sixteen-mm film is expensive, difficult to edit, and troublesome to utilize. Videotape and thermoplastic tapes probably would be more feasible because of re-usable recording strips. A library of classic or rare cases then would be available for students and teachers.

The psychiatric instructors functioned as interviewers, interlocutors, and classroom observers. Each interviewing psychiatrist had to learn simple staging. The instructional team improved case presentations by analyzing and criticizing each interviewing psychiatrist. The interlocutor's criticism is particularly valuable because he is the most experienced person at the point of delivery. It is extremely important that group leaders who know case details be present during clinical studies to provide meaningful group interaction. Students also tend to identify strongly with the patient and need guidance with their emotions.

Television seems to facilitate increased student participation. "Case-hungry" freshmen and laboratory-weary sophomores were more informed and satisfied, and seniors were able to pit their wits against the instructors.

Patients who enter a teaching medical center usually accept being under observation as an exchange of services. In order to meet medical ethics, however, permission had to be obtained for televised interviews. The facts were presented less specifically, the patients being told that students would be observing their interviews. With the exactness of the procedure underplayed, patients' apprehension at being observed was usually not sustained after other feelings moved into focus. The privacy of the 2-person interview was maintained, giving television its greatest advantage. Of 91 interviews, only one patient (a nurse) showed hour-long awareness of being observed. The psychiatric resident did confess to tension during the first 9 hours of being on camera.

While cameramen and monitors did the technical work well and with interest, they did not have psychiatric perception. Medical students, such as psychiatric residents, could have participated in camera work, as they have done with motion picture projection.

Some of the most instructive cases were those where patients resisted the psychiatrist's efforts and he had to demonstrate his clinical skill in order to proceed. Demonstrations of lengthy psychotherapy did not hold student interest. Perhaps because of decreasing student-motivation, television may not be practical for lengthy processes.

Potential uses of television could extend to a psychiatric faculty member providing on-the-job clinical supervision of students, interns, psychiatric social workers, and nurses. The staff also would be better informed, thus assuring more proper patient care. The hazards of a "big brother" situation should be measured against the offsetting situational gains. Participants would be required to treat all disclosures as confidential. St. Francis Hospital (Mason City, Iowa) and Nebraska Psychiatric Institute have televised wards and rooms, both to relieve nursing shortages and to observe the critically ill, confused, postanesthetic, and suicidal patients. With improved equipment we can expect more widespread use of this method for psychiatric services.

Videotaped psychiatric interviews could be used for more effective examinations. They could be standardized to fill certain criteria. Such examinations would circumvent the subjectivity of the examiner, and by pretesting or simultaneously testing faculty, television or film tests should be more reliable and fairer than many present tests. In the hopefully near future, specialty board examiners might include televised interviews of candidates examining selected patients. Evaluative studies are now in order. Extensions of television applications should be investigated for undergraduate, graduate, and continuing education, and for its applied medical sciences.

6.5 Tucker, H., Lewis, R.B., Martin, G.L., and Over, C.H.R. "Television Therapy," AMA Archives of Neurology and Psychiatry, Vol. 77, January 1957.

The first study of TV for therapy resulted from the observation that patients seemed to improve when commercial television was placed in the ward. A 6-week daily observation confirmed first impressions, with the result that TV sets were placed in all 63 wards and it was decided to investigate whether further improvement would result from closed-circuit therapy.

A studio was set up and 141 female patients were split into experimental and control groups, matched for seven characteristics such as age, type of mental illness, length of hospitalization, activity level, etc. Two hypotheses were set up: (1) therapy can be administered effectively in a simulated face-to-face situation through the medium of closed-circuit television, giving the impression of individual therapy while administering to a large group; (2) by means of closed-circuit television, motion pictures dealing with mental hygiene and other educational subjects, filmstrips, and other suitable materials also can be presented effectively. Criteria for improvement were to be clinical estimates made by the attending psychiatrist, tests and ratings before and after therapy, and increase in permits for visits out, leaves, and discharges.

Panel and group therapy, art and music therapy, psychodrama, question-and-answer programs, and selected motion pictures were used continuously throughout the program. The hypotheses were both upheld. It was concluded that mentally ill patients improve significantly in behavior patterns when given therapy by closed-circuit television in the areas of communication, interpersonal relationships, socialization, self-care, work, activity, and recreation. Psychotic patients have amelioration of symptoms and improvements in social and interpersonal relationships, and response to stimuli. Many worthwhile therapies are of little value because of inability to deliver them economically to a large number of patients, but the closed-circuit television method would appear to allow their more extensive application.

6.6 United States Veterans Administration. Project Video. Psychiatric Service of the Veterans Administration Hospital, Oklahoma City, Okla. June 1961.

This demonstration project evaluated closed-circuit television for psychiatric services. A basic portable television camera chain was rented for 6 months. In addition to the camera, monitor, audio-video mixer, and one receiver, the project used 300 feet of coaxial cable, two microphones, and a staff intercom part of the time.

Lack of familiarity with television caused some initial staff apprehension. Committees were formed involving psychiatric staff and representatives of other services involved in patient care. During an orientation period, both staff and patients were familiarized with equipment and reasons for using it. Initial fears that patients would feel spied upon proved groundless, for patients are accustomed to observation and accept it as part of treatment.

The projects focused on exposing the staff to an objective evaluation and study of behavior. Patient interviews were televised as part of a formal teaching case presentation and group therapy sessions were televised of acute and chronic schizophrenics, manic-depressive psychotics, psychoneurotic patients, and patients with personality disorders. Time limitations made post-therapy sessions with the observing staff impossible except for a student nurse group. Reactions of observers who did not participate in post-therapy discussions indicated that observation should not be permitted unless the observer agreed to participate in the postobservation discussion. Residents observed resident interviews of newly admitted patients (usually acutely ill psychotics) who had been seen only once before in the admissions office by a psychiatrist. Observations of sleeping subjects were correlated with dream material, always with the full knowledge and approval of the patient. Television was used in conjunction with a postgraduate symposium at the hospital and also to provide participants in regular staff meeting with an objective view of the meeting.

Staff relationships among the conference members showed up more clearly through this standoff view, which led to a gradual reorganization and defining of structure and objectives for these 3-time-a-week meetings. There was no incidence of patient violence or undue disturbance attributable to the experiments. When project objectives were explained, there was universal patient acceptance and willingness to participate. Although anxiety was expressed at the beginning, during interviews there was relative ease and freedom, with both therapist and patient soon forgetting the camera and/or monitor and becoming so engrossed in the patient's problems that the observers felt "left out." A natural termination occurred when patient or therapist refocused attention on the equipment and unseen audience. In every instance the consultant was able to elicit more personal information and the patient seemed more relaxed and less threatened than with a large group of staff members. The patients when asked confirmed these observations. Some consultants were unenthusiastic about TV because they were accustomed to using audience reaction as an integral part of the teaching process. The viewing staff was relaxed and pleased to participate freely in discussion during the interview without disturbing the participants.

Evaluation emphasized the need to predetermine objectives. The equipment performed excellently, but for a permanent installation, improvements not needed for a 6-month experiment would have to be made. Future television as an integral part of the psychiatry department could include orientation for patients and new staff members. The patient should be able to discuss what he learned and the staff to discuss gains through using TV in relation to administrative and therapeutic policy, thus providing additional means to improve patient care (i.e., televised family interviews might hasten therapeutic process during early phase of illness).

6.7 Ward, C.H. "Direct Electronic Preceptoring," Journal of Medical Electronics, Vol. 37, 1128-1129, October 1962.

It is generally agreed that teaching beginning-psychotherapy is inherently difficult. Clinical learning situations are complex and cause students emotional confusion. Much of the difficulty may lie in the technical aspects of teaching, which instead of affording direct learning experiences, offer uninvolved, vicarious, and insufficiently specific methods. At the Pennsylvania School of Medicine direct electronic preceptoring has been tried as a teaching aid for 4 months, and promises some amelioration of these difficulties.

Direct electronic preceptoring permits the teacher to be in the interview situation while physically removed, enabling him to monitor the therapeutic exchange and offer counsel to the student without the patient's awareness. It appears to facilitate teaching of diagnostic interviewing, to offer considerable aid in imparting psychotherapeutic understanding and skill, and to provide a sense of support to the beginner. It has also been useful to the seasoned therapist in special situations.

The teacher, watching in an adjoining room through 1-way glass or via a closed-circuit television console, monitors the session using a conventional sound pickup system. He comments into a microphone having a convenient on-off switch and the sound is amplified by an audio amplifier in the viewing room and fed into a wire loop under the rug of the interview room. A micro radio receiver in the student's pocket picks up the signals magnetically and transistors amplify the sound enough to operate a hearing-aid-type ear speaker. Thus, the student has complete freedom of movement. Reception is excellent and adjustable, while inaudible to the patient. This 1-ounce unit is very tiny. The entire sending-unit costs less than a medium-priced tape recorder. The device could be made like a spectacle-frame hearing-aid and operated by bone conduction. This seems unnecessarily involved and expensive, since the device need not be concealed to deceive the patient; only a means of unobtrusive teacher intervention sans patient awareness was sought.

Prior to the interview, tone and volume should be adjusted to a level optimal for the particular teacher-student pair, preferably with an outside auditor to insure that volume is not loud enough to be evident to the patient. Comments by the teacher must be terse and should be made during pauses to avoid distracting the student or overparticipating so as to place the student in a puppet role and rob him of growth. Interjections are best at important junctures or nodal points. A prearranged hand signal to request restatement by the teacher is also helpful.

Students, in the main, have adapted easily to the "third ear" and have had little difficulty in receiving and adapting comments to their needs. Students were aware of some initial perturbation, but it was not evident to seasoned observers. Most students seemed substantially comforted by the apparatus. The electronic device facilitated identification between seniors and faculty, as the latter frankly revealed their limitations. Also, increased confidence and heightened interest in learning the skills of interviewing have seemed to accompany the introduction of this particular teaching device. An independent research project done by two seniors indicated that 70 percent of the first 27 students using the device felt increased confidence, 85 percent felt they had gained in interviewing technique, 86 percent preferred it to interviews in which the teacher participated directly, and 87 percent preferred its use over unmonitored sessions. Ninety-two percent felt the device had increased their insight and 36 percent reported some initial adaptation anxiety.

All observers agree on how little the hearing-aid device seems to inhibit patient spontaneity. No patient, not even two experienced ones, commented about the hearing-aid speakers. It was evident that the device was intuitively recognized. Its meaning may have been so deeply threatening that it could not be faced or accepted, but on the other hand, repression may have indicated no great trauma, simply moderate caution and a saving of response. The writer prefers the latter explanation. While there was no hesitancy in informing the patients about the electronic apparatus, this was not done for the first 40 interviews in order to test patient reaction relative to their treatment, but to date, there has been no reaction. In 10 diagnostic interviews the device was explained to patients. No difference in reaction was detected. However, there were first interviews in a teaching setting where patients are accustomed to student-teacher care.

The teachers were almost uniformly enthusiastic about the apparatus even in the planning stage. To date, 9 out of 10 have used direct electronic monitoring and have appreciated its facilitation of diagnostic interviewing and the fact that they can be occupied helpfully while the student is working instead of trying to correct the student later when errors have mounted. An unanticipated benefit has been increased involvement of the student audience in the viewing room with the teachers, who are now able to share the creative process of ongoing interviews. The teachers adapted to the instrument as easily as the students. Direct electronic monitoring has proven especially helpful to the seasoned therapist who is doing demonstration therapy because there is no loss of spontaneity or repressed segments of material. This leads to a belief, still untried, that this device may be useful in the psychiatric consultation.

The electronic device has its limitations. It is at best a tool. While it can facilitate learning, capacities of both teacher and student remain primary. Some teachers use this device more effectively than others -- a tendency to overactivity probably being the greatest difficulty. Some students are uncomfortable and block out interjections or become confused. Some patients talk so fluently that making interjections is nearly impossible and others have defenses so complicated that teacher-student communication during the actual interview becomes chaotic.

6.8 Wittson, C., and Dutton, R. "A New Tool in Psychiatric Education," Mental Hospitals, 1956.

The Nebraska Psychiatric Institute was designed and built with TV conduit and video and audio equipment installed. The cost was $18,000, including three vidicon cameras, three 17-inch monitors in the control room and a 6 x 7 foot, large-screen projector in the 176-seat auditorium. Three custom-built camera carts carry sound equipment, lenses, cables, microphones, and related equipment including an 8-inch monitoring set. The cameras can be operated as far as 40 feet away from the junction boxes at 6 locations. Other conduits terminate in camera-closets from which treatment rooms can be televised through 1-way glass. These rooms have microphones built into the ceilings and light level controlled by rheostats in the camera-closets.

Since the Institute already had several audiovisual aids, including a 2-way telephonic network with other State institutions, they hired a full-time electronics technician, a part-time coordinator of television programing, and a consultant in medical electronics. The Institute encourages their faculty to prepare scripts in documentary style even though a great deal of ad-lib dialogue is apt to occur. This encourages the faculty to think visually and, indeed, the two rules for deciding whether a program is to be produced are whether the program will have substantially more impact through a television presentation and whether the script is feasible in expense and preparation time. A manual has been prepared to guide faculty members in preparing the shooting of scripts. In almost every case a full-scale rehearsal precedes the actual telecast, including live cameras, music, props, narration, titles, visuals, and lighting.

The television system has been of value for conducting tours of the Institute without disturbing intrusions. It has aided nurses on the two maximum-security units by providing complete surveillance without leaving the station. The televised patient interview has replaced the 1-way mirror and allows 200 students (instead of 6) to see and hear simultaneously. Moreover, a lecturer can comment on the interview as it takes place, and visual aids can be introduced as desired.

The Institute is now exploring the use of dramatic sequences to add emotional underscoring to certain points in lectures, based on the patient's trauma. They are also planning evaluative checks using TV and non-TV student groups to determine the impact, if any, of this medium of presentation on the learning situation. Preliminary response indicates that television has been helpful to students. This first year of television has certainly proved technically satisfactory and effective teaching programs have been produced at modest cost. The Institute anticipates expansion in the near future.

6.9 Wittson, C.L., Affleck, C.D., and Johnson, V. Nebraska Psychiatric Institute, University of Nebraska College of Medicine, 1962 Annual Meeting of the Council on Medical Television. "The Use of Two-Way Television in Group Psychotherapy" (The same material also appeared under the title "Two-Way Television in Group Therapy," by the same authors, in Mental Hospitals, November 1961.)

Two-way television could facilitate inter-staff consultation and planning between mental health personnel concentrated in one urban location and others in units located in surrounding, but often distant, areas (such as isolated State psychiatric hospitals). Evaluation of the use of 2-way television led to a study of its application in the psychiatric hospital group-therapy situation. Findings are based on the results obtained by using two group therapists, each working with four groups apiece, on a six-session basis, under the direction of the investigator responsible for the study.

Each patient chosen for a group was seen by one of the investigators prior to selection. The patients were informed that the purpose of the groups was to discuss their problems, and those who were to be televised were told that an interesting new technique was being tried. These patients were shown the technical aspects of the system before the first session and were introduced to the technician and the clinical investigator, who, they were assured, were the only observers. No patient refused to participate although several failed to appear at the appointed time. No effort was made to arrange the groups on the basis of diagnosis, type of problem, or degree of disturbance, except to screen out the more disturbed or manifestly agitated. The groups were comprised of both men and women, in units of four to six people.

The groups met in a large room with their chairs in a "V" arrangement, so that each patient faced the monitor where the therapist appeared; an unobstructed view of each member of the group was thus provided and face-to-face contact was maximized. The camera was directly above the screen showing the therapist, and a fixed shot of the group was used to eliminate distractions by the technician. Two monitors placed separately from both group and therapist enabled the technician to check on the technical problems in audio and video transmission and at the same time to provide a clear, revealing profile of the process. In training therapists, clarity of facial expression and nonverbal communication with attendant effect on group response is of particular interest.

The wired closed-circuit system used two vidicon camera chains. High-intensity illumination proved a major distraction, so that different vidicon tubes were introduced in both cameras to provide lower-level illumination and effective video transmission. All receiving systems were identical. The system is mounted on a cart with the television camera fixed above the monitor.

After each therapy-hour both the group and the therapist rated the session. Results of the group members' rating indicated no significant difference between the TV and non-TV situation, but did differentiate between the therapists. The therapists' group rating also showed no difference between these situations, but, as with the group's rating, indicated scale differences between the therapists. The scales employed in the study, therefore, appear to differentiate therapist and/or group differences only, not "TV vs. no TV" differences. It would seem then that televised group therapy has no effect on brief group-therapy situations. Thus, 2-way TV group therapy techniques may provide a means of extending therapeutic procedure from areas where skilled mental health persons are concentrated to surrounding areas where they are scarce.

Radiology

7.1 Banks, G.B. "Television Pick-up Tubes for X-Ray Screen Intensification," Radiology. November 1958.

It takes at least 30 minutes for the eye to attain maximum sensitivity to the darkroom but the gain may be as much as 10,000 times -- indicating the degree of image brightening required to compensate for dark adaptation. In fluoroscopy unaided by electronics, limits to perceptible resolution and contrast occur because of thickness of material and geometrical blurring because of the finite size of the focal spot of the X-ray tube. Also, degree of resolution and contrast are dependent on the number of energy quanta available per elementary area of the image during a given interval. In fluoroscopy, this interval is the storage time of the eye -- about 1/10 of a second.

With an X-ray intensifier of the static type a light amplification of 12 to 15 is obtained in the tube, and this, together with a viewing optical system enabling the eye to collect a fair proportion of the light, results in a thousandfold gain over the unaided eye. Resolution is restricted only by the screen. Static intensifiers represent a definite advance and have enabled some diagnostic work that would otherwise be impossible. Devices developed for television have been utilized for X-ray intensification, and offer unrestricted coverage of the patient, with great brightness and amplification and easy viewing. Nonlinear effects may be introduced into the circuitry to modify contrast and obtain more information.

It has been concluded that the performance of the standard 3-inch orthicon, although greatly superior to the unaided eye, falls short of the ideal screen intensifier and, for full advantage of a television fluoroscopy system, a pickup tube of superior performance is required. To this end, an experimental 4½-inch image orthicon has been developed. Because it is advantageous to increase the light falling on the photocathode of the pickup tube, a tube has been developed that can be used in conjunction with a reflecting optical system, the latter incorporating a spherical mirror of 18-inch diameter. When this article was written, clinical tests of the tube were awaiting arrival of a new mirror optical system, expected in 1958. It was hoped that publication of performance data for the complete system would be available at an early date.

7.2 Botden, P. "Introduction to X-ray Television," Medica Mundi, Vol. 4, No. 3, 1958.

Low brightness level on the X-ray screen was vastly improved by a factor of about 1,000 by using an image intensifier. The higher brightness level gives considerably greater detail perceptibility. Because this achievement is partially due to reduction of the image size, optical systems were needed to enable the radiologist to obtain optimum benefit. With the advent of television, screen brightness was no longer the limiting factor in the perception of detail. The television pickup tube, the vidicon, combines with other components to provide high contrast. The resultant contrast is still of such magnitude that, in principle, most diagnostic examinations can be done with the combination of image intensifier and vidicon closed-circuit. The image intensifier is now coupled to the vidicon camera by means of a tandem lens system consisting of two objectives. The circular image on the viewing screen is projected onto the photocathode and the image becomes visible on the monitor screen, with consequent freedom of position for the radiologist with respect to the patient. Examination technique permitting, there is no longer any need for a position close to the patient. Radiation hazard to the radiologist can be reduced or even avoided completely. Several monitors can be connected to the camera control unit. Cable can transmit the X-ray image to a lecture room situated at some distance, and aerial transmission with link connections is technically possible.

7.3 Botden, P.J.M. "New Development in Image Intensification and X-ray Television," Medica Mundi, 1959.

The introduction of the image intensifier to radiology was a revolutionary improvement. Its brightness allowed substantial gain in detail perception and eliminated dark adaptation, although full room lighting sometimes impairs detail perception. Moderate dosage requirements also allowed full development of cinefluorography and X-ray television. In spite of the image intensifier's great possibilities, the need arose for viewing-screens larger than 5 inches. Attempts were made to link an ordinary fluoroscopic screen and highly sensitive television camera to a wide-aperture optical system or to put an X-ray screen reproduction onto a light amplifier and the amplified image again onto a television camera via a larger aperture optical system. In these systems the X-ray image intensifier was avoided as the main element. These apparatus were too large, and a medium-size intensifier built on the same principle as the 5-inch image intensifier was needed. Certain conditions were sought: effective diameter of the viewing screen -- large enough for total examination of the adult heart or both kidneys, the whole stomach, skull, etc.; a high brightness gain for cinefluorography and X-ray television; universal adaptability to various X-ray techniques and particularly to simultaneous application of more than one technique; close doctor-patient position by means of relevant optical systems; an image intensifier attachable to any desired X-ray stand and usable as a self-supporting unit; and minimal electric connections. No additional techniques should be foisted on a radiologist who prefers his own diagnostic procedure, and functions should be controlled via the existing operating switch. All these and a few other conditions have been met with the development of the 9-inch image intensifier.

The overall length of the 9-inch intensifier does not exceed that of the 5-inch one. It is built into a shield for radiation protection. The author has used the mirror viewer, but in view of the advantages of high luminance amplification for cinefluorography and television, has maintained monocular viewing. The 9-inch mirror can be displaced or rotated for successful use with most X-ray stands. The tube's relatively short length makes it possible to examine standing patients successfully with a binocular viewer. By mounting three mirrors on a rotating spindle, an image distribution can be produced that is able to allow for the various combinations of optical systems and to apply both fluoroscopy and cinefluorography during the same examination.

In X-ray television, four categories may be distinguished: the combination of fluorescent screen with highly sensitive image orthicon camera including maximum-aperture optics (increased in sensitivity by placing of a light amplifier between fluorescent screen and highly sensitive camera by wide-aperture optics); an X-ray image intensifier combined with a highly sensitive television camera via a medium-aperture optical system; an X-ray image intensifier combined with a lightweight vidicon camera via wide-aperture optics; and the roentgen vidicon. The roentgen vidicon, although basically an attractive system, needs fundamental improvement with regard to decay-time. The fluorescent screen combined with an image orthicon camera produces noise in the monitor image, which is one of the main limiting factors in detail perceptibility. This effect can be corrected partially by using an image orthicon with a greater diameter of the useful photocathode. A light amplifier, image orthicon camera, and wide-aperture optics are very expensive but will do an acceptable job. Use of an X-ray image intensifier instead of an optical system permits use of the vidicon television camera. A number of problems had to be solved before universal application of X-ray television could become a fact. One was the great variation in brightness for the output screen of the X-ray image intensifier during the examination, causing greater variation in the picture with quality loss in the dark or light portions of the X-ray image. A workable signal-stabilizer was added, and a contrast-improver was incorporated into the television chain that was effective for examining details in the fluorescent image more closely and that allowed an additional contrast intensification in a restricted part of the total brightness range so that details of weaker contrast could be observed under optimum conditions. The radiologist is free to use a control knob to select any detail and any brightness level within the brightness range. Since it has been found in X-ray cinematography that either a positive or sometimes negative X-ray image may be preferable, provisions have been made to permit this selection by means of a switch.

7.4 Campbell, J.A. "The Advantages and Disadvantages of Cinephotofluorography in Routine Diagnostic Examinations," The New Physician, December 1961.

Cinefluorography is motion picture photography of the dynamic images on a fluoroscopic screen. Before the development of image intensification methods, X-ray movies lacked sufficient brilliance of the screen unless prohibitive levels of radiation were given the patient. New, brighter fluoroscopic images, with good definition and more reasonable radiation levels, are available through a significant increase in the field size of the intensifier.

There are two basic types of screen intensification: (1) from the electron image-intensifying tube through a mirror-optical periscope and (2) the image orthicon tube, which receives the optically reduced fluoroscopic image from the output end of a reflector camera. The television image is transmitted to the viewing monitor for fluoroscopy, and kinescopic cinerecordings are taken directly from the screen of a second, remote monitor. Modifications of these two systems include image electron and TV-orthicon intensifiers combined into a single instrument to decrease radiation, and a system with a small, light-amplifying electron image tube between the reflector camera and television camera to permit direct cinerecording from the output phosphor of the light-intensifying tube. Many cineradiographic devices use synchronized radiation bursts from the generator to sharpen the image and limit radiation exposure. The extent to which these instruments allow appreciation of physiologic and pathophysiologic kinetics is medically important. The quality of cinereproduction is about the same in any of today's commercial machines. The greatest disadvantage is their limited resolutions, with test patterns rarely above 40-line pairs to the inch. The choice of film is between high-gain tubes with slower, fine-grain emulsions for improved image definition or low-gain tubes with faster, coarse-grain emulsions for lower radiation doses. Fast film is also needed to examine thicker parts. The advantage of larger film size is offset by present restriction in image tube resolution. The 35mm film captures more detail than 16mm film of similar emulsion.

7.5 Duckett, G. "Daylight Telefluoroscopy," American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. 74, No. 3, September 1960.

Since 1958 the Jean-Talon Hospital in Montreal has used television in its diagnostic radiology department to replace a fluoroscopy room, and radiologists no longer use dark glasses, aprons, gloves, and dark adaptation of the eyes. The landmarks in the development of teleroentgen diagnosis include a broadcast in 1950 of a fluoroscopy image of a foreign body being removed from the chest, a French broadcast of the actual fluoroscopy of a barium-swallow miles away, and a microwave broadcast of the television images of the output phosphor from various examinations.

Any modern roentgenographic table can be equipped easily for remote control merely by motorizing the parts which are usually handled by the radiologist. The author's hospital has a large table with movable top for lateral and axial displacement. The spot roentgenographic device has been replaced by a combination 5-inch television camera, 16mm cinecamera, and 7mm spot-film camera. Any part of the body can be examined by any fluoroscopic technique, and the 70mm camera provides a record of diagnostic value. The author and his colleagues have made 6,000 different examinations in 2 years. Usually, diagnosis is established earlier, since the television image differs very little from roentgenographic quality. The dose is lower and allows longer study periods. Radiation received by the patient is 10 times less by daylight, as compared to darkroom radiology.

All this is achieved by use of the image intensifier, which increases brightness of the fluoroscopic screen a thousandfold, for cineroentgenography and telefluoroscopy. Successful results from the image intensifier television camera combination led the author and his colleagues to use remote control radiology. Their interest in telefluoroscopy extended to audio-video communication with another hospital 3 miles away, through a coaxial cable, for consultations and relay of information within minutes. They have experimented also with kinescope and videotape, which are promising methods of recording television images of diagnostic value and of further eliminating extra time and radiation exposure. Videotape is preferable as a method of storage, since it is more accurate and is excellent for recording a large number of examinations, which can then be read by two or more radiologists.

7.6 Fisher, J.F., and Gershon-Cohen, J. "Color Translation and Contrast Enhancement of Roentgenograms by Television Techniques," Journal of Albert Einstein Medical Center, January 1957.

Information is transmitted from an X-ray film to a television video signal by a flying-spot scanner system. Contrast perception of the human eye is rather limited if brightness is not markedly different. By electronic means it is possible to clip all video voltage, both above and below any given level, and then restore the gain to its normal 100 percent value. Video information of interest may thus be restored to the full dynamic range by increasing the gain by as much as 20 times. The difference in brightness, which could represent two adjacent areas of interest on any X-ray film, is increased and the contrast is readily perceptible. Clipping and gain controls are arranged so that any selected portion of the full dynamic range may be displayed in contrast-enhanced form for diagnostic purposes. For easy control an oscilloscope is incorporated into the equipment. It is true that slight contrast enhancement can be achieved by merely adjusting the brightness and contrast controls on a television picture monitor, but enhancement with this apparatus is far greater.

In addition to use with monochrome, the various gray shades are sometimes advantageously displayed in different colors. The apparatus to make this color translation includes an electronic color converter and the color monitor. The monitor is a 21-inch diameter cathode-ray tube employing separate electron guns for the red, green, and blue signal. A contrast-enhanced monochrome video signal is fed into the input of the color converter. The video voltages from black to white level are converted to saturated colors going through a gamut of blue, cyan, green, yellow, and red. It has been found effective to display video voltages near black level as blue, at 25 percent level as cyan, at 50 percent as green, at 75 percent as yellow, and 100 percent as red. The eye sees fine detail in an additive color picture in terms of luminance variations and is not equally sensitive to color changes in various parts of the spectrum. This translation method helps greatly to identify relatively small, but separate, areas of equal brightness because these are displayed in the same color on the color monitor. In many cases, it has been found desirable to use both monochrome and color monitors to gain the fullest diagnostic information

7.7 Garthwaite, G.W. "Ancillary Equipment for Use with Image Amplifiers Employing Television," British Journal of Radiology, Vol. 34, No. 407, November 1961.

Unlike the image on an output phosphor of an electrostatic image tube, the reproduction of a television picture is not a continuous process. The image on the cathode-ray tube of the monitor is written on by a beam of electrons, which scans the picture area orthogonally. After any given field scan, the next two field scans are slightly displaced vertically and the scan fills in the spaces left by the previous scans. After each third scan, a given element in the original scene will have been rescanned -- a process known as interlace -- which reduces brightness flicker and makes best use of the frequency bandwidth available in the electronic amplifying circuits.

Photography of a television monitor requires the camera shutter to be driven at a multiple of the speed at which the picture appears on the monitor. The motion of the cinecamera must be synchronized in the correct phase relationship with the television picture. Otherwise, an unexposed bar will appear on each frame of the film even if the camera speed is correctly synchronized. A system known as "target pulsing" improves sensitivity. The scan of the television system normally occurring during the shutter-closed period of the cinecamera is pulsed off, and the information arriving at the television camera tube is stored until the next active camera scan occurs. Unnecessary X-ray exposure to the patient during alternate frames is thus avoided. To save film and produce more detail, the camera can be driven at 12½ and 6¼ frames per second. Changes in filming speed are effected by alteration of the gearing between the motor-driven shaft and the camera-driven shaft and the camera, using interchangeable packaged gear units.

A 100mm spot-film camera records high-definition, still pictures from the television system, which are suggested as replacements for conventional full-size radiographs. The still camera is focused on a television monitor whose screen is electronically blanked out except during exposure time. Used in conjunction with a television-type image amplifier, the still camera allows remote installation, less danger of fogging of the film by scatter X-ray radiation, and high brightness on the cathode-ray tube with a consequent ability to use slow-speed and fine-grain film. With the 100mm spot-film camera, a much lower X-ray dose is possible.

7.8 Girdany, B., Gaither, E., and Darling, D. "Large Screen Image Amplification with Closed Circuit Television Employing Television Tape Recorder," Radiology, Vol. 77, No. 2, August 1961. pp. 280-291.

Every effort must be concentrated on limiting the amount of radiation during examinations. The recently opened X-ray department at Pittsburgh Children's Hospital utilizes television tape recording of the fluoroscopic image, mediated through a newly developed image orthicon camera coupled to a 9-inch image amplifier optically. The system permits videotape recording and simultaneous viewing on closed-circuit monitors at the same low levels of radiation required for closed-circuit viewing alone.

For the past decade the optical coupling of vidicon cameras with 5-inch image amplifiers made it possible to record the fluoroscopic image on monitors, thus allowing more than one person to see it but necessitating increased radiation for adequate visualization of the observed field. Satisfactory cineradiographic film recording of the fluoroscopic image on the amplifier also required a major increase in radiation.

The television X-ray system offered the advantage of television viewing at diminished rates of radiation but left the television image unrecordable. Kinescopic movie-film recording is difficult and moderately expensive. Tape recording affords the ideal method for reproduction of the monitor's picture. It also can be played back immediately to all fluoroscopic rooms. An additional cable from the camera to the tape recorder allows recording from each fluoroscopic unit at the radiation level required for closed-circuit monitor viewing.

The efficiency of optically coupling the vidicon camera to the image phosphor was 10 percent, with a 90 percent loss. It should be possible to combine a vidicon camera directly with the image amplifier in the same glass envelope and thereby eliminate light loss, but this arrangement would be impractical because breakdown of the circuitry could necessitate scrapping the entire combination. Image orthicon cameras are about 1,000 times more sensitive to light than vidicon cameras. The orthicon circuitry is more complex and its camera costs more. The optical coupling of an image orthicon camera with a large-field image amplifier would appear ideal for viewing the fluoroscopic image. The image orthicon tube allows viewing of the fluoroscopic picture at levels of radiation similar to or below that employed in standard image amplification. It was possible to place the complex orthicon circuitry remotely with respect to the image amplifier so that the bulk of the combined amplifier and camera would not be a factor in practical application of coupling.

One manufacturer attempted to link the orthicon camera with a light intensifier, hoping to pick up light directly from a standard fluoroscopic screen and deliver the intensified image to the camera. This attempt was unsuccessful because in pulling the lens back far enough to include the entire intensifier screen, the loss of light was great enough to make the system impractical at acceptable radiation levels. It would therefore appear that any satisfactory system must utilize electronic amplification methods employed in currently available image intensifiers.

The television fluoroscopic system currently used at the Children's Hospital contains an electronic magnifier that doubles the size of the television image when small areas are being observed. By effectively scanning with twice the number of lines, the magnifier enhances details in small areas. Four fluoroscopic rooms are connected by coaxial cable to the main control center and television tape recorder. Remote monitors are installed in the chief radiologist's office and the X-ray reading room.

Convenience of viewing and improved teaching are the major advantages of closed-circuit television observation of fluoroscopic images. Simultaneous viewing by unlimited numbers of observers is practicable. Supervision of trainees by senior men is feasible.

The addition of television tape-recording amplifies the described advantages. Tape recording of the television image is carried out at the same low levels of radiation now employed for closed-circuit monitoring (0.13 to 0.5mμ and 60 to 80 kv.). It may be stored or transferred via a cinerecording camera to fine-grain movie film (for single frame or slow-motion viewing, currently impossible on videotape). A prime consideration is reduction in radiation to patients through avoidance of reexamination. The recording on the tape is erasable. The dozen or more people who would be involved in reexamination are replaced by the taped examination. The resident in radiology can be supervised and tested without costing patient radiation or work time. Reviewing taped recordings of his examinations allows the fluoroscopic examiner to concentrate fully. The technical quality of the examination if certain and allows the examiner to rely on seeing what he needs. Immediate playback allows him to check his impressions in this respect. The low levels of radiation needed for recording allow prolonged or repeated examination with less radiation exposure.

A library of fluoroscopic examinations can be available. The availability of sound-recording on the television tape offers a new, largely unexplored field for simultaneous studies of motion radiography with sound, which has immediate application in the understanding of speech and cleft palate problems.

7.9 Greenwood, F.G. "Television Cine-radiography," Proceedings of the Royal Society of Medicine, Vol. 54, August 1961.

Television has solved the problem of allowing for more than one observer of a fluoroscopic examination. Remote monitors are ideal for teaching. Two methods are used: the image intensifier together with a vidicon camera to scan a modified conventional screen, and the orthicon camera. The latter is complex and more expensive than the vidicon and its use without the intensifier omits a light gain of over 1,000 times. Advantages of the orthicon system include an increased size of field and definition of the monitor, and improved gray scale in the adoption of a 1,024-line system in place of the 525-line type. It is inconvenient, however, because of its great bulk and restriction of cinematographic work in filming from the television monitor. The apparatus has great versatility: the monitor can show negative or positive images; the image can be magnified by 2 by the orthicon camera and can be inverted; a lens of 25 instead of 15mm focal length allows further magnification of the film image by 2.

It is essential for this costly apparatus, when not in use, to be readily detachable from a standard X-ray table, which can then be used for routine work. Many patients having gastrointestinal examinations require ordinary films rather than cineradiograph, and the screen carriage should have facilities for the exposure of ordinary radiographs and a serial device and compression cones. This applies also to urological work. Best results are achieved by ceiling-mounting the whole lens and orthicon system for ready replacement by conventional fluoroscopic screen. It is then also possible to use the table for standard radiography with an overhead tube.

Negative film can be processed and viewed in about 2 hours. This film and a positive monitor image probably give great radiographic detail, but when the X-ray beam is coned or shuttered down, the surrounding unexposed area of the film is distracting. Printing positives eliminates this, but the cost is high, and it may be equally satisfactory to film the negative screen image or to use reversal film. The polarized phased motor, camera, and gears can be installed outside the X-ray room, thus saving space and eliminating noise.

7.10 Hanley, H.G., Greenwood, F.G., and Scott, M.G. "Recent Advances in X-ray Television -- with Special Reference to Urology," British Medical Journal, May 1961.

Since the previous reports of 1955-57, we have had 5 years of experience with various forms of X-ray intensification, and it is easier to assess routine clinical value against academic-interest value. Certain criteria still apply for the urologist. Screen or monitor viewing must be binocular, since it is insufficient for him to be told what the radiologist sees without seeing it for himself. Viewing must be possible without acrobatics. Field size is important. A small field allows better definition, but a large field allows localization first. It must be possible to take spot-films with minimum delay and the apparatus must be easily accessible for the urologist and anesthetized patient.

A bright visual image can be produced on any standard fluorescent screen by using a high X-ray output, but the radiation dosage limits time. A solution to this problem is in sight through the use of electronic devices to amplify weak signals, in themselves not strong enough to produce a visual image. The more visual light, the smaller X-ray dosage is needed. Previous television fluoroscopy systems used an image intensifier tube to provide the light-gain and a vidicon camera scanning the output phosphor to produce a visual image. The orthicon television camera gives light-gain by scanning the output phosphor to produce a visual image. The orthicon television camera gives light-gain by scanning a modified, conventional fluoroscopic screen, and the final visual image is produced on a special high-definition 1,024-line television monitor. There is greatly increased definition, improved gray scale of the monitor picture, and increase in field size. This increase is more important to cardiac work than to urology. The image can be doubled in size, shown on the monitor as a positive or negative shadow, and projected upside down; however, the orthicon is expensive and bulky, although advances are expected to alleviate these conditions.

It was originally thought that filming the television monitor was a major difficulty, but this has not proved true, the cinecamera has to be phased to the 50-cycle input main, but two of the speeds are very conveniently close to the standard sound and silent projection speeds, and ample light and contrast make fine-grain 16mm film possible. It is easily processed and projected within a few hours and end results are in every way comparable to photographing the phosphor. A 35mm is no longer necessary.

Applications with greater or lesser value to urology have been made in excretion pyelography, retrograde pyelography, cystography, gastrointestinal examinations, bronchography and angiography, myelography and ventriculography, orthopedics, and hysterosalpingography.

Further experience with X-ray intensification by the authors indicates that some form of television monitoring will become standard practice. The orthicon system apart from its larger field would appear the most efficient and versatile apparatus available, and seems to offer more scope for future development than combination intensifier tube and vidicon camera.

7.11 Hawley, C., Mendez, F.L., and Maurer, E.R. "Television Bronchography," Radiology, Vol. 77, No. 4, October 1961.

Bronchography under television control at Christ Hospital (Cincinnati) has expedited the handling of patients. A completely lighted room eliminates dark adaptation for the operator and eases the patient's apprehension. Intubation can be controlled carefully, since the physician and his assistant view the position simultaneously on the television screen. Technicians can move about freely. This is an excellent instructional medium. A remote monitor serves for teaching or other purposes during the procedure.

Premedication is paramount to good topical anesthesia of the tracheobronchial tree. A barbiturate and other medications are given an hour and a half before examination, and the patient is brought to the radiology department on a stretcher. Additional medication and anesthesia are administered, the catheter is applied, and the patient is properly positioned and transferred to the X-ray table. A technician is assigned to control the catheter, direct it into appropriate areas, and instill the material being used to outline the tracheobronchial tree. Following visualization, appropriate radiographs are obtained. Television makes bronchography a very simple procedure.

7.12 Henny, G.C. "Medical Applications of Fluoroscopic Image Intensification -- I," IRE Transactions on Medical Electronics, June 1959.

Since Roentgen's discovery in 1895, X-rays have been produced by bombardment of a target with electrons. During this process much of the X-radiation is lost; a rather narrow beam is left to enter the patient and, because of differences in absorption by body parts, to produce an X-ray shadow. The information may then be extracted by using an X-ray film, which, if enough X-ray reaches it, gives a good shadow picture. Much of the X-ray striking this film will pass through it, so this method is quite inefficient. Efficiency is increased by adding intensifying screens on both sides of the film for greater absorption of X-rays that are then converted to fluorescent light. The screens, however, have some graininess and this adds to unsharpness of the shadow.

Another recording method, the photofluorographic method, involves making a photograph of the fluorescent screen. This gives a reduced-size film and is not too efficient -- only a small amount of the X-ray image light enters the camera lens and only that light can be thrown on the film to darken it. From 2½ to 20 times as much X-ray may be required. In order to overcome the single view presented by these methods, a fluoroscope has been developed so that after the X-rays pass through the patient, they fall upon a fluorescent screen for direct observation. The screen is not very bright, however, and improvement of intensity discrimination and detail requires increased intensity of the X-ray beam. With humans, increased dosage would be unacceptable.

The image intensifier has alleviated the brightness problem. Photoelectrons are emitted in proportion to the X-ray intensity on the particular area of the screen. There are a number of electrostatic lenses followed by a phosphor layer which is aluminum-backed to prevent feedback of the light and to reflect it out in the forward direction. The lenses focus the electron image and reduce it from a 3-inch diameter to a 1-inch diameter, at the same time increasing brightness 25 times. After the electron image is converted to a light image on the output phosphor, magnification may be employed. The patient may be positioned in any way. The image may be photographed, and excellent motion pictures may be taken without excessive X-ray exposure to the patient. There is some loss of detail with image intensifiers. A television camera also can be focused on the intensifier and the picture shown on the television screen.

7.13 Janker, R. "Cineradiography with Image Intensifier and Television," Medical and Biological Illustration, 1960.

The electronic image intensifier increases image brilliance so that every detail can be easily recognized. Two methods have been devised: one where X-rays create a relatively weak image on a primary screen in a vacuum tube and electrons form a secondary, fluorescent image 800 to 1,500 times brighter than the primary one (the image can be observed through a magnifying glass, photographed, or filmed); and the other, where the weak image on a full-size fluorescent screen is projected on the much smaller photocathode of an image intensifier by a wide-aperture mirror optical system and is then processed as in the first method. For television, the weak image on the fluorescent screen is projected onto the photocathode of a camera tube. The electrons create a proportional potential on a storage plate that is scanned by an electrostatically controlled electron beam.

The image orthicon is most suitable for radiographic purposes. It has high storage capacity, and its image is so bright and contrasting that even a dim fluorescent image is intensified. With a special high brilliance receiver, cinematography can be effected by synchronizing the film camera to the television scanning frequency of 25 f.p.s. Television allows multiple observers. A vertical turntable has been designed for conventional cineradiography at the institute the author is affiliated with. For examining a standing patient, the X-ray tube, fluorescent screen, and television camera are arranged on a common axis and firmly fixed on the rotating disk. A switch can alter the deflection current of the image orthicon for scanning only the central area of the screen, and the lead diaphragm is also closed by remote control to reduce radiation. A monitor serves observers in the same room as the patient. Installed in a side room is remote control equipment for intensification, image scanning, and electronic focusing, and other controls allow vertical and horizontal orientation and negative or positive presentation of the image. Thirty-five mm film records are made from a special monitor with automatic control for synchronization. Controls transpose images from the two cameras from one monitor to the other and they select the image to be transmitted to the lecture theater. Sound-recording can be combined easily with cinematography without interference.

The 13 cm. intensifier is easily detached and stored on a wall-fixture. One vertical turntable is equipped with either a 13 cm. or 18 cm. image intensifier in conjunction with an image orthicon television camera. A mobile monitor for the examining radiologist and simultaneous recording reduces radiation. A 23 cm. intensifier can be attached to screen equipment interchangeably with the normal fluorescent screen. The secondary image can be diverted to an observation mirror, film, or television camera, and the instrument has an exposure meter to adjust current to a predetermined point for a constant density range on the processed film. A 3.15 cm. image intensifier is also available. Both the mirror and X-ray tube can be moved vertically and turned through 90 degrees. A meter permits constant film exposure by adjustment of the tube current. This device can be linked with a television camera.

The described apparatus afford an opportunity for comparative investigations of resolution, contrast, and radiation dosage. The relationship between screen and reproduction format must be considered. Definition suffers as the area to be recorded increases in relation to reproduction format. Image intensifiers, unlike television systems, cannot be made to adjust the contrast of the image. At the author's institute it is impossible to imagine radiological investigation of the heart and large vessels without television.

7.14 Jutras, A. "Teleroentgen Diagnosis by Means of Video-Tape Recording," The Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. 82, December 1959.

Videotape recording is done by means of electronic signals emitted by a television camera and registered on a strip coated with ferro-magnetic oxide. Videotape can be used for audio recording and can be erased for re-use. Videotape radiology requires proper equipment to fluoroscope any body part with images sufficiently bright on the television receiver. Resolution is somewhat improved since grain, or "snow," is eliminated. However, the videotape is capable of transmitting only what it has actually received, and recordings and playbacks are more difficult to use. Television signal frequencies are considerably higher, and passing images must supply much information in each fraction of a millionth of a second. Accordingly, infinite signals must emerge from each line of a picture to secure sharpness and contrast for reproduction on television screens. Videotape width and length are increased to handle more signals.

Good condition of tapes and head is essential for perfect retransmission. Tape costs about $400 for a 64-minute reel but it may be used more than 100 times before becoming defective. Thus, an hour program can be recorded and played for less than $10 in tape expenditure. The heads should be reconditioned after 100 hours of continuous use. An outlay of about $400 is needed for repair, but it is again prorated by actual use. Videotape requires no chemical processing, and can be played back fully or partially after rewinding. Rewinding time for a complete 1-hour reel is 3 minutes, and immediate review a matter of seconds. No expert electronic knowledge is necessary for operation, but maintenance and repairs must be handled by professional technicians. Videotape allows savings in film, chemicals, processing, film storage, clerical work, and time for radiologists, consultants, and patients. The recording, simultaneous with fluoroscopy, eliminates successive cinematographic and roentgenographic phases and thereby decreases radiation exposure to the patient. Technical factors and positioning are maintained at their best, since they are under constant visual verification. Videotape, unlike unexposed film, is not fogged by radiation. It may be handled in radiologic rooms in daylight.

The practicability of special interconnecting hospital/physician's-office networks should be investigated. At present, two Montreal hospitals are experimentally linked by coaxial cables. A circuit servicing several hospitals and scores of doctors would be complex and videotape would be indispensable. It is recommended that a few suitable departments first be equipped experimentally with videotape and film recorder before the cooperating hospitals become too deeply involved.

Videotape is expensive and there has been objection to its impracticality for storage. Sequences can be copied on motion picture film, however. Kinescopes could be made and recording limited to sequences of definite interest. Images can also be frozen on the videotape monitor and photographed with regular film or polaroid paper. A videotape recording can be played back only on special equipment which is not portable or easily available. Kinescope reproductions, however, can be made on 16mm film. This method is restricted to special examinations because of the small, 5-inch size of the area seen by the image intensifier, although wider image intensifiers are being made. The definition of television images does not equal conventional roentgenograms, but motion of organs can be reproduced by videotape recording. The greatest advantage of videotape recording for diagnosis is the additional protection of patients from radiation hazards.

7.15 Jutras, A., and Duckett, G. "Roentgen Diagnosis by Remote Control, Telefluoroscopy and Cineradiography," Medica Mundi, Vol. 4, No. 3, 1958.

In radiology there is a lack of radiologists, increasing cost of equipment, and growing complexity of equipment operation. These difficulties are a hindrance to health insurance and prepaid hospitalization plans. There has been insufficient technical orientation toward helping the radiologist with recording, coordinating, and distributing information. Inadequate automation is time-consuming. Snapshots of the fluorescent screen often lack precision and examinations in the darkroom are tedious to the radiologist and anxiety-making to the patient. Television and cineradiology offer daylight fluoroscopy, more efficient and accurate service to more patients, and rapid transmission of information to attending physicians and surgeons. Until recently, cineradiography criticisms about photographic qualities of frames and complexity of manipulations were justified.

The key element of modern cineradiography and telefluoroscopy is the image intensifier tube, which acts as an electronic light-amplifier. Examinations can be conducted in rooms with subdued light without dark accommodation, and daylight reassures the patients. For geneticists and cancerologists in particular, image intensifiers improve visualization for faster decisions, shorter fluoroscopy time, and increased brilliance with less radiation dosage.

Cineradiography is finally practical. The 35mm films have high photosensitivity, although they have to be reduced to the 16mm size, which is inconvenient, costly, and time-consuming. With an equipped laboratory close at hand this inconvenience would be minimal, however. A new 16mm film is now available that costs less, has decreased manipulation, and makes possible the use of a smaller camera. This reversal film can be processed in a small automatic developing tank machine in full daylight at the rate of 600 to 700 feet per hour.

Teleradioscopy is still limited by smallness of the surface of the patient fluoroscoped with the image intensifier of 5-inch diameter and large size of lines forming the television image. Corrections are progressing, however. Fluoroscopy with television assures the radiologist of absolute protection against X-rays. At present, telefluoroscopy alone cannot provide a solution to radio diagnosis until television screens are equal to film for sharpness of details.

A new apparatus has been installed at Jean Talon Hospital in Montreal. It has a rotating ringstand supporting the examination table, X-ray tube, and motorized compression cone, and it provides 180-degree tilting in both directions. The table top on which the patient rests is movable for examination of various parts of the body. The X-ray tube is fixed at a permanent distance so that the beam always remains centered coaxially with the image intensifier at the viewing orifice in the lead surface of the tabletop. There is also a battery of television cameras and monitor screens, an automatic and rapid processing machine for cinefilms, an enlarger, a copying machine for 16mm films, and a series of cameras for vertical and horizontal radiographs on 70mm film. Two image intensifiers, one coupled to a motion picture camera, the other to a television camera, form the core of the new apparatus. A system of two lenses has been constructed which gives a numerical aperture of 0.9 and which constitutes an excellent receiver of light.

7.16 Lindblom, K. "Roentgen Television in Surgery with Special Reference to Stereo-Television," Acta Radiologica, Vol. 53, 1960.

With transmission of the fluoroscopic image to the screen of a television tube, the surgeon has a larger field of vision, he can see his hand on the monitor, and he can be seated more comfortably. Ordinary roentgen television equipment was tested in the department the author is affiliated with, but involved unduly high roentgen doeses. When an image intensifier and vidicon camera were employed, satisfactory images were obtained only with thin patients. A vidicon camera connected to an amplifier was found satisfactory for examination of extremities.

Since 1958, the author's department has used an image intensifier and an orthicon television camera with conventional receiver, a setup which has proved more satisfactory. The image is conveyed from the intensifier through lenses and a mirror into the camera. The intensifier rotates about an axis passing through the mirror, permitting any projection. The apparatus has been used mainly for removal of renal calculi during pyelotomy, removal of ureteric calculi, reduction and nailing of fractures, studying the emptying of the gallbladder and urinary bladder, and investigating motility during cholangiography and cholegraphy.

Parallactic displacement is used for localization in the third dimension. The apparatus recently has been modified for stereotelevision by having two roentgen tubes fitted and energized alternately at a frequency of 25 c.p.s. The television screen is examined through glasses with perforated discs that rotate synchronously with each beam cycle. Consequently, the two images on the television screen are seen separately by each eye.

The roentgen load required is about the same as with conventional fluoroscopy, and the television image is bright and satisfactorily contrasted. Except for very small renal calculi, roentgen television during nephrolithotomy allows extraction of calculi under visual control, and the time required for reduction and nailing of fractures of the femoral neck has been significantly shortened. In order to reduce radiation to the surgeon and assistant, the primary diaphragm of the roentgen tube is fitted with a cone and a lead, and firmly pressed against the patient's body.

7.17 McCarthy, J.F., and Ritter, J.S. "Colored Motion Picture Photography and Black-and-White Television of the Human Urinary Bladder and Other Interior Body Organs," The Journal of Urology, Vol. 78, No. 5, November 1957.

Adequate telescopic systems have been available for inspection and diagnosis of the urogenital system, such as the panendoscope using a foroblique telescope with other accessory right-angle and retrograde telescopes. Miniature tungsten coil lamps have provided adequate illumination for visualization and diagnosis and under ideal conditions, for black-and-white photography, with exposures up to 1½ seconds, or color photography of 4 to 5 seconds. Experimentation has been done with miniature lamps with heavy tungsten filaments to operate at higher voltages for shorter periods, and also with accessory lamps flashed by overloading voltages. Exposure time was thus reduced for black-and-white or color, but it was impractical to make frequent changes of lamps and accessory equipment. Other methods required dangerously high voltages. Limited application has been found for illumination of internal body cavities by light-transmitting materials such as glass, quartz, and plastic rods. Experimental cystoscopic equipment provided superior light generated by an incandescent source, collected by an optical condensing system, and transmitted through the tube to the distal end of the instrument, but the equipment was too cumbersome to be practical.

The panendoscope was successful in televising the interior of the bladder and marked a great advance for visualization and teaching of various urological procedures. The sheath has a cone offset to accommodate the accessory light-transmitting source. The optical system consists of an enlarged version of the foroblique telescope attached to a cylindrical container to mount the telescope and to retain the optical condensing system, which collects the light and transmits it to the quartz light-conducting tube. A 50- or 100-watt incandescent 8-volt light bulb having a prefocused filament is attached to a socket, and a flexible cable provides voltage to illuminate the lamp and circulating air to keep it cool. A low-pressure centrifugal air supply system is in an accessory case containing an indicator lamp, a rheostat for voltage regulation, an isolation transformer for power source, and a footswitch for overloading lamp voltage if desired. This light is sufficient for still pictures at exposures of 1/25 second at a working distance of 3/4 inch. For still, colored pictures a reflex camera with adapter has been used successfully. Color motion pictures at 16 frames per second and black-and-white television are practicable.

For television, the camera containing the image tube is coupled to the ocular end of the foroblique telescope. The bladder interior is observed by an operator and/or observers on the cathode-ray television viewing screen. The same telescopes and illumination systems are used with motion picture camera as with the television arrangement. This system provides means of obtaining motion pictures of benign and pathological bladder conditions and operative urological procedures. Television is the more spectacular of the two procedures but requires many adjustments, some of which are now being formulated. The authors feel that color motion pictures are ready for immediate application.

7.18 Mackay, R.S. "Television Cineroentgenography: Dose and Contrast Factors," American Journal of Roentgenology, February 1961.

Contrast in the original, unconverted roentgen-ray image depends on wavelength distribution. This may be monitored with a scintillation detector and the gray wedge pulse height analyzer. This unit gives a spectrum from a tube running under normal operating conditions without requiring exposure-time comparable with the tube life, and various machines thus can be adjusted to give comparable outputs. When the television image is photographed, film density is not relevant to intensity or dose, since the television output can be brightened arbitrarily. The dose can depend only on the detail to be resolved. If photography is used in rendering the roentgen-ray image visible, then film nonlinearity can be augmented electrically to make saturation transitions more abrupt outside the range of interest.

More may be visible in movies than in stills. With a standard sound camera the dose will be 2.5 times that necessary to produce the given image quality because the camera shutter is closed for three-fifths of the time and resolution will be only half that potentially present because successive fields do not appear on the same or successive movie frames and there is little chance of interlace. A shutterless recorder with continuously moving film or a camera with "instantaneous" film advance will avoid loss of information or excess doses. Mechanically, the continuous-moving-film camera seems the most durable.

A magnetic videotape recorder proves to have enough bandwidth to replace the camera for many purposes if the image quality is always degraded by dose reduction to the minimum acceptable. This unit uses a resolution of approximately 400 lines horizontally and 500 lines vertically, which is about as good as the information the detector used by the author supplies at low light levels. It also has the shutterless camera to avoid loss of interacting quantum, and can be used as an erasable, intermediate storage unit to transfer to film. The record is available for immediate study or redoing. Image processing can be optimized by varying parameters while comparing modified and unprocessed images on two monitors. With tape recorders time, labor, and extra equipment for film processing are eliminated. Fast rewind sometimes allows almost the same result as with single-frame viewing, which can be provided by using a storage tube. The image is relatively satisfying and is useful clinically.

The effect of a nonlinear system on the signal-to-noise ratio is difficult to predict. However, when fluctuations in a brightness level are all correspondingly small, contrast-enhancing nonlinearities will not significantly change this ratio. Large noise pulses will diminish in relative effect after contrast enhancement if limited by a saturation nonlinearity, while the smaller, useful signal is expanded. With an image orthicon, the scanning-beam must be no more intense than necessary. A synchronous camera motor eases problems of hum, pickup, stray magnetic fields, and power supply ripple, mainly because induced non-uniformities tend to be stationary with respect to the image.

7.19 Mallet-Guy, P. "Television Radioscopy During Operations on the Biliary Passages," Surgery, Gynecology & Obstetrics, June 1958.

Unavailability of radioscopy formerly required the surgeon, in order to reduce the number of radiographs, to use manometry of the biliary passages to assist in interpreting X-ray films. Various devices have been suggested for radioscopic control during an operation, such as placing an assistant in a "coffin" under the operating table, but the responsibility would then belong to the radiologist and the surgeon would become a technician. The image amplifier used in cineradiography allows daylight viewing in clear, correct-sized pictures, but it is available only to the viewer, and violates asepsis.

With television, an image seen by a surgeon and his assistants can be relayed throughout the whole suite. The apparatus used includes a portable X-ray set, image intensifier with circular field, optical device to transmit as bright and clear an image as possible, small high-sensitivity camera to brighten images, a control stand for camera and equipment, controls and screen for the surgeon, additional television receivers, and a cinecamera synchronized with and focused on one of the receivers. The tube is placed below the operating table, which is not radio-opaque. The camera is over the patient, centered over the tube. Television does not replace, but rather supplements, radiography and manometry. Most information is obtained by radioscopy immediately after pressure reading and, combined with manometric data, often allows complete diagnosis at once. The total time can be halved and does not exceed 5 minutes.

Radioscopy can provide new precision by detecting or excluding diagnosis of stones in the common bile duct. It eliminates the need for a succession of control radiographs, as the screen will tell at once if the obstruction has been removed. It can help in the early diagnosis of growths. It allows the surgeon himself to gauge the evidence and draw conclusions without time loss.

7.20 Matsuda, H., Nagaoka, T., Takai, G., and Ninomiya, K. "Medical Applications of X-Ray Television," American Journal of Roentgenology, Vol. 85, No. 2, February 1961.

In radiology, invaluable protection against radiation hazards were found by limiting the roentgen-ray beam with a multishutter and by shielding the operator with lead walls. The image intensifier reduced dosage remarkably to patient and radiologist, and improved detail perception in fluoroscopy. The radiologist still continued his studies in the fluoroscopic room because there was no suitable optical device to allow observation of an image intensifier in another, radiation-free room. Also, the image intensifier could not be used alone, since its visual field was only a 5-inch circle. An intensifier and routine fluoroscopic screen had to be used alternately, or the intensifier had to be moved over several regions of the patient to perform comprehensive examinations. A 9- or 11-inch intensifier would lower the radiation dosage. Considerable research on using X-ray television has been done in Japan. In 1959 closed-circuit television for roentgen diagnosis was installed in the radiology department of the Center for Adult Diseases, for performing basic and clinical examinations, the first unit of its kind for practical use in Japan.

The authors' X-ray television system consists of a high-tension generator with a controller, a tilting table with rotating anode tube, a 5-inch image intensifier, and closed-circuit television with a 14- and 17-inch screen of the ordinary television picture tube for fluoroscopy and indirect roentgenography. A television camera and monitor for general view of a patient and tilting table are also provided. Radiologists can view the fluoroscope image through television screens in the control room and examination room, and many physicians can participate. Both direct roentgenography on the tilting table and indirect fluororoentgenography through the television monitor are possible. A universal dose meter is employed, and 10 plates of plexiglass are used as a phantom. In using any of these techniques, one can estimate roughly the dose received by the patient during fluoroscopy.

Radiologists can freely carry out teleroentgenography by using the monitor under conditions of routine fluoroscopy while they perform telefluoroscopy with the same monitor. Telecineroentgenography was performed by photographing the roentgen-ray images on the television monitor with a 16mm cinecamera in the control room. It proved of definite diagnostic value.

The authors have adopted the vidicon system rather than the image orthicon because the device with the former system can be operated by radiologists without engineers, and the signal-to-noise ratio of the televised roentgen-ray image is far better than that of the image orthicon camera. The image orthicon is much more sensitive and capable of catching the image on the conventional fluorescent screen without the aid of the image intensifier, but this leads to conspicuous deterioration in detail perceptibility. The limits of the vidicon X-ray television system were felt when images of certain body parts were insufficiently clear, such as the bony structures of the hip joint, head, upper dorsal spine, and the lateral view of the lumbar spine. The authors feel that the following are workable improvements: increase in milliamerage, use of more sensitive vidicon tube in low brightness level, and improvement in efficiency of optical component between the image intensifier and vidicon camera. An X-ray television unit is now under construction with this in mind. The patient dose in telefluoroscopy is greater than in fluoroscopy using the image intensifier. Telecineroentgenography seems to have advantages over cinefluorography when the image intensifier is used. In fact, cineroentgenography employing X-ray, visible on the television monitor, appears to be one of the most useful techniques in the domain of roentgen diagnosis.

7.21 Morgan, R.H., and Sturm, R.E. "The Johns Hopkins Fluoroscopic Screen Intensifier," Radiology, October 1951.

Recent attempts to brighten or intensify fluoroscopic screens have been made with an electronic tube capable of intensifying the fluoroscopic screen about 150 times. Moon, at the University of Chicago, is working toward "flying spot" screen intensification and anticipates large gains in screen brightness. The authors' research was concerned with fundamental physical and physiological factors influencing fluoroscopic vision. They have completed an instrument, now under laboratory testing, designed to yield gains in screen brightness of 1,000 times or more.

The intensifier comprises a conventional fluoroscopic X-ray generator, an X-ray image detector, and a fluoroscopic viewing unit which includes an image orthicon converter tube. The intensifier combines the optical principles of photofluorography and the engineering principles of television, a combination that permits considerable flexibility. The size of the field need not be limited, as in the case of screen intensifiers of the image tube type, but can be designed to approach the size of conventional fluoroscopes. Amplifier circuits permit increases in contrast levels with considerable improvement in clarity of image reproduction. A phasing switch allows images to appear either in positive form, as they occur on conventional fluoroscopic screens, or in negative form, as on X-ray films. Since illumination is well within the range using cone vision, no dark adaptation is needed.

In its present form, the resolution of the screen intensifier falls considerably short of limits theoretically possible, but it was extremely unlikely that ultimate resolution limits would appear in the first unit. Experimental studies are showing progress. It also seems easy to make X-ray motion pictures directly from the kinescopic screen. These films may be exposed with the X-ray generator operating at normal fluoroscopic kilovoltages and tube currents. Motion pictures can cover a period of several minutes. The intensifier can also apply the amplified current to a kinescope of the projection type. Such a kinescope projects its images on a screen similar to that used for lantern slides, thereby allowing group viewing, which seems feasible for teaching medical students and physicians in a way not heretofore possible. The clarity of reproduction possible with the projection kinescope seems almost as good as that seen on the standard kinescope of the screen intensifier. At present, the screen intensification equipment is too bulky and complicated for the convenience of most radiologists.

7.22 Morgan, R.H., and Sturm, R.E. "Roentgen-Ray Motion Pictures by Means of Screen Intensification," The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. 50, No. 1, July 1953.

Roentgen-ray motion pictures, or cinefluorograms, are technically difficult for experimental radiology. The film quality is poor and radiation exposure high. All diagnostic information recorded is carried to the film by the roentgen-ray photons that pass through the patient. With a large number of photons, diagnostic information in the film is relatively high, and conversely, with a small number of photons, the quantity of information is low. Since radiation exposure is proportional to the number of photons involved in the roentgenologic process, and since the quality is essentially a direct function of the amount of diagnostic information recorded by the film, roentgenographic quality bears a close and fundamental relationship to radiation exposure. When films of relatively great detail are desired, "definition" screens, which require long exposure are used; for less detail, "speed" screens using small exposure are used. The authors expect ultimate improvement in present-day equipment. Much can be done by a more effective use of radiant energy delivered to the cinefluorographic unit, and detail improvement is possible by increasing the film size to 35mm instead of 16mm. Full-sized roentgenographic film has been, and can be, used to record essentially all the detail included in the roentgen-ray beam. However, the cost of film and associated equipment is high, and the film is difficult to move at the frame speeds demanded by motion picture procedures.

The screen appears relatively efficient, and gain in lens resolution of more than 2 times does not seem likely. Solving these difficulties appears to lie in the direction of applying screen intensification methods to cinefluorography. A screen intensification system brightens fluorescent images by several thousand times and makes possible the use of photographic lenses of high resolution and films of fine grain. The increase in light permits roentgen-ray motion pictures with considerably less radiation exposure. There is some sacrifice of detail, but under some circumstances this does not matter. Roentgen-ray motion pictures using screen intensification can aid teaching and experimental procedures where investigations are either drawn out, or prohibit an excessive amount of radiation.

7.23 Morgan, R.H. "Screen Intensification: A Review of Past and Present Research With an Analysis of Future Development," The American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, Vol. 55, No. 1, 1956.

The premise that fluoroscopic clarity will follow an increase in screen brightness should not be wholly accepted until it is certain that the causes of poor visual acuity at low illumination levels will not also influence the performance of any man-made optical device used to increase screen brightness. Limitations of the human eye may also be caused by factors which limit all types of optical systems. Diagnostic information from a fluoroscopic image is carried from the patient to the screen by myriads of roentgen-ray photons that comprise the beam. Diagnostic information provided by a fluorscopic screen can be no greater than the sum of all the increments of information carried to the screen by the photons. Clarity is a function of the number of photons falling on the screen during the fluoroscopic process. A beam of high intensity will produce images considerably greater than one of low intensity. It is a valid conclusion that an increase in the milliamperage applied to the roentgen tube will allow more to be seen. The grain size in the fluoroscopic screen does not control clarity of detail. The introduction of a screen intensifier will not improve clarity of fluoroscopic vision if it only increases brightness with increasing efficiency of roentgen-ray photon utilization. It is only because the eye utilizes a small fraction of the information carried by the roentgen beam that screen intensification holds promise of success.

Research has yielded practical instruments to increase or intensify luminousness of fluoroscopic screens, such as those employing simple electron optical systems, those using storage-type television circuitry, and instruments based on the flying-spot principle of television. Electron optical intensifiers are simple, relatively inexpensive, and have a great theoretical ability to improve efficiency of the fluoroscopic process of allowing observers to see a level closely approaching 100 percent. Disadvantages include a somewhat limited increase in brightness over conventional screens, small field size, a low inherent contrast, and a tendency to undergo deterioration in image quality during examinations of thick structures. Some workers have had to view the intensifier through an optical device, and freedom of motion was inhibited. Storage-type television intensifiers have a relatively large gain in brightness, a screen size that can be tailored to almost any need, high and controllable image contrast, and no need of special optical devices. Disadvantages include relatively great complexity of design and comparatively high cost of roentgen-ray photons of efficiency less than 100 percent. However, the storage-type television intensifier has proved useful where other methods did not solve the problem. Very little success has yet been had with flying-spot television intensifiers. Screen intensification has been most widely applied to cinefluorography. Long roentgenologic sequences can now be made with motion pictures having cinefluorogram quality equal to, or greater than, that of films using previous techniques. Intensifiers of both the electron optical and television types are being used with cinefluorography.

7.24 Potsaid, M.S. "Kineradiography," New England Journal of Medicine, 1961.

Kineradiography, radiography of kinetics, may be used to describe studies of motion obtained by radiologic means regardless of the augmenting system, which does not change the basic principles of analysis and interpretation of dynamics. Kineradiography has medical importance because of its appreciation of the physiology and pathophysiology of body structures.

Conventional motion recording with television limits the film detail and frame speed. More than 525 lines per frame are necessary for fine detail, and for motion analysis, more than 60 cycles per second of alternating current are required. These limitations may be overcome by using 1,000 lines per frame at 120 cycles per second. A permanent record of a television image on video magnetic tape is costly, and cannot be analyzed satisfactorily by slowing or stopping frames. Some television systems employ extremely light-sensitive cameras with image orthicon tubes that look directly at the fluorescing screen. The television circuit increases brightness and changes contrast without an image intensifier. Devices can deliver .001-second pulses of X-rays that expose each frame only when the film is stationary, lowering radiation dose to the patient. More refined diagnostic studes are produced by such advances as improved geometry of X-ray tube target-to-object, screen and film distances, smaller focal spots on X-ray tube targets, proper kilovoltages, finer grids, accurate exposure times, faster fine-grain films of higher contrast, and better film processing. Developments peculiar to movies include faster optics with less distortion and vignetting and smoother camera mechanisms that improve kineradiographic images.

Kineradiography is important to experimental and clinical medicine because it provides a permanent record of function. In motion of structures, X-ray movies permit analysis of height, width, depth, and also give a practical measurement of the 4th dimension, time. An interesting teaching and research application of motion X-ray studies is time-lapse roentgenograms of living bone, which offers a more dynamic visualization of skeletal changes. Kineradiography allows recording of function in intact, untreated subjects, sans interference of tools or drug effect from anesthesia. Cinecardiometry and cine-electrokymography are newer methods of analyzing kineradiographic images, and they give much quantitative information about anatomic and hydrodynamic events. Structural motion can be represented graphically. Kineradiography allows thorough study with a single dose of radiation, and total exposure can be reduced drastically. To reduce optical viewing errors to the level of movies requires an increase in dose above that required for movies. As kineradiography becomes more widely applied, aberrations in dynamics are likely to be appreciated earlier, resulting in earlier diagnosis. In medical teaching, animal experiments can be replaced by human demonstrations and improvements are expected in such postgraduate specialties as radiology. Kineradiography is also producing a communication problem. Edited copies of actual studies should be more widely distributed in journal form, preferably as supplements to current radiology periodicals. The cost of producing a 100-foot reel of film should not be prohibitive, considering the number of copies to be produced. A research project to study the feasibility of such supplements and to cover the cost of publication might be undertaken by one of the radiology journals.

Experiments on stereoscopic X-rays have met with only moderate success because equipment limitations imposed restriction in taking and viewing these studies. Current trials of 3-dimensional radiographic movies indicate that there may be at least two relatively simple ways to analyze and interpret films. A 10-second type movie film, with its rapid processing, may be another improvement. A plastic film that stores information on its surface combines the processing speed and versatility of magnetic recording and storage capacity of photography.

7.25 Silverman, F.N. "Doctors Use TV to Watch X-Ray," Hospital Management, 1958.

At the Children's Hospital of Cincinnati, television is used for diagnostic purposes. It developed as a consequence of an active cardiac service. With image intensification, catheterization procedures became possible in normal room light and the patient could be under continuous observation -- factors that tended to alleviate some of the anxiety surrounding potentially hazardous diagnostic procedures. There were the inadequacies, however, that the optical system could serve only one or two persons, and that the physician manipulating the catheter had to be guided by descriptions from the radiologist.

A relatively inexpensive commercial television camera was obtained, and with no radiation increase gave a clear, enlarged image of the area under examination. It was also used for heart catheterization studies and for teaching. For storage, a special film processing machine has been developed which fixes and dries film in 9 minutes and, in a few more minutes, the radiologist can project the demonstration.

Another problem was the crowding of residents into the teaching room to watch one inadequate television set. Additional viewers, connected by coaxial cable to the monitor, were considered, but the units are expensive and, also, they carry only a video signal with no sound. Teaching requires the spoken word to augment the visual image. Fortunately, provision had been made for installation of a television aerial system for the children's use, and it was a relatively simple matter to arrange for extra connections to conference rooms and from the fluoroscopic room into one of the channels not in use for commercial television. An audiovisual mixer converted the signal from the camera into one which could be picked up by standard television receivers. A microphone permitted simultaneous transmission of the examiner's voice from the fluoroscopic room to the antenna on the roof and then to any television set properly tuned. The hospital felt secure about parents or children tuning it because the channel is ordinarily unused, shadows are unintelligible even to physicians familiar with fluoroscopic anatomy, and verbal descriptions were couched in strict medical terminology.

The television screen has not replaced the standard fluoroscopic screen. The televised image is generally less distinct than a directly viewed fluoroscopic image. Fine viewing still requires direct optical viewing, or even a return to fluoroscopy with dark adaptation. However, anticipated improvement and low radiation add to the reasons why television is here to stay, at least for certain types of procedures.

7.26 Stauffer, H.M., Oppenheimer, M.J., Steward, G.H. III., and Blackstone, A.W. "Practical Image Amplifier Technics; Fluoroscopy, Cinefluorography, Spot-Film Radiography and Uses with Closed Circuit Television," Radiology, Vol. 65, No. 5, November 1955.

The authors have employed an amplifier with an ƒ: 1.5 50mm lens mounted at its focal length from the output phosphor with emergent rays approximately parallel. The camera lens, focused at infinity, is brought into apposition to that of the image amplifier. Fluoroscopic viewing is done either through the amplifier lens or by right angle telescope. A television pickup can be substituted for the motion picture camera. The authors have found it feasible to process relatively short runs of 16mm film using a standard X-ray solution right in the X-ray darkroom, and to project them, in such cases as with angiocardiography, within an hour. The detail of projected single frames does not equal that of the conventional roentgenogram but much can be learned of dynamic processes by viewing the films as motion pictures, unlike still radiographs. A stereoscopic effect is simulated by the respiratory and rotatory motion of the patient, giving additional information by the slight differences in projection.

Image amplifiers might be used best other than in darkened standard fluoroscopic rooms. The authors are adapting image amplifiers to the multiplane fluoroscopic type of mounting, permitting convenient cinefluorography and daylight fluoroscopy and providing a cassette channel in front of the face of the image amplifier for direct spot-film radiography. This will permit flexibility in positioning the patient and the X-ray beam.

Encouraging preliminary results were obtained by photographing the amplifier image with a 60-second camera. A vidicon closed-circuit television and monitor system can be used readily with the image amplifier. X-ray intensities, little more than used in conventional fluoroscopy, provide a usable television image of the lung fields of adults or of other portions of the body in children and laboratory animals. In another application, it is feasible to make measurements for stereo-encephalotomy by visualizing on the television screen the intracranial needle employed in the procedure.

7.27 Stauffer, H.M. "Medical Applications of Fluoroscopic Image Intensification -- II," IRE Transactions on Medical Electronics, Vol. ME-6, No. 2, June 1960.

The statistical fluctuation in X-ray quanta causes limitations with image intensifiers. While greater fluoroscopic information can be obtained, it is probably a misconception that it is done with less radiation exposure to the patient than is usual for conventional fluoroscopy.

One arrangement of the image intensifier is in the form of a mobile unit with self-contained X-ray generator and tube mounted for ready, on-the-spot manipulation, without moving the patient. The department the author is affiliated with also uses another intensifier, incorporating a mirror-viewing system and motion picture camera. The output phosphor is 1 inch in diameter and the input viewing area is roughly the same as the aforementioned tube -- about 5 inches in diameter. Even though X-ray motion picture camera synchronization has not been used with the equipment, no fluctuations have been observed at film speeds of up to 64 frames per second.

In X-ray cinematography it is desirable to have the part of the patient or animal being examined in motion. Even if the organ itself is still, it is desirable to move the patient as a whole, so that overlapping shadows can be overcome, multiple projections obtained, and often, stereoscopic effects produced.

The author's department has experimented with an industrial high-speed camera running at 250 frames a second. This camera has a right-angle optical system for recording from an oscilloscope simultaneously with the image intensifier to record the blood pressure curve or electrocardiogram. After testing, the equipment was found, with both millisecond X-ray exposures obtained with the dynapulse and with constant potential X-ray excitation of the intensifier at 500 frames a second, to prevent blurring any appreciable motion. This same test was carried out in reverse, that is, a rotating lead disk with a slot cut-in was used. Similarly, there was no spreading of the periphery of the slot image when films were made with the intensifier at 250 frames per second.

Commercial closed-circuit television has been used to transmit and display the intensifier image successfully. An increase of X-ray intensity is required to produce a satisfactory television image. This amounts to about 3 times the intensity required for direct vision of the intensifier screen.

7.28 Stauffer, H.M. "Some Newer Electronic Developments in Diagnostic Radiology," Journal of the Louisiana State Medical Society, Vol. 113, No. 8, August 1961.

Barium platinocyanide was used for many years for diagnostic fluoroscopy. Subsequently, calcium tungstate was employed for the fluorescent screen as suggested by Edison, in one of the first intensification systems enhancing the effect of X-rays on photographic film through the light produced by the fluorescent effect. As early as 1908, a British engineer suggested the elements of cathode-ray scanning and in 1931 he demonstrated an apparatus for transforming an X-ray image into an optical one by electronic means. Practical fluoroscopy developed more slowly. The introduction of the zinc-cadmium sulphide yellow-green fluorescent screen about 1935 was considered a dramatic improvement.

Information both from here and abroad guided and stimulated X-ray and electronic manufacturers to brighten the fluoroscopic image at a time when the art of fluoroscopy was in danger of total eclipse because of the emphasis on radiation hazards. The present electronic image intensifier tubes make possible visualization of the fluoroscopic X-ray image of patients in lighted rooms at reasonable X-ray dosages. Television has freed the observer from clumsy viewing systems and fluoroscopic machines loaded with electronic gear, and has allowed simultaneous viewing by many observers from many sites. Recordings can be made directly on movie film or videotape, although the latter is still rather expensive.

Modern image intensifier fluoroscopy with its decreased radiation dose is causing a revival of interest, particularly in specialized procedures. Television presentations of fluoroscopy during heart catheterization are now commonly carried out in a lighted room with operating team, students, and visitors able to observe the progress by X-ray. Storage tubes have also been used to display single exposures for several minutes at a time on the television screen, at greatly reduced radiation exposures. X-ray observation during the endoscopic removal of a foreign body from a laboratory animal, with simultaneous television presentation, has been successfully demonstrated. The author and his colleagues are currently studying the feasibility of presenting stereoscopic fluoroscopic images on two television monitors to be viewed with appropriate polarized glasses. Initial results have been encouraging.

With the image intensifier it is now possible to study patients through cineradiographic techniques. Most commercial apparatus still require sizable X-ray doses. In the hospital the author is affiliated with, the X-ray movie has been used in connection with gastrointestinal and heart systems, because motions here occur so rapidly there is really no other satisfactory way of completely studying physiologic activity. Pressure and sound recordings can be made simultaneously. The hospital's radiology-physiology research has used X-ray movie filming at higher speed, currently 270 frames per second to obtain new basic scientific information.

7.29 Stauffer, H.M. "Stereoscopic Fluoroscopy by Intensifier and Television," (Final progress report for U.S. Public Health Service Grant No. CS 9681), 1962.

Although other methods are being tried elsewhere, it appeared to the author and his colleagues that the most simple and direct way for them to test televised stereo-fluoroscopy was to use an existing twin X-ray tube array and 2 image orthicons with targets pulsed at 60 pulses per second. This tube permitted a fixed beam-splitting mirror and an acceptable 50 percent light loss. The right and left eye images are sorted by pulsing the image orthicons out of phase with each other. The two sync-generators are locked to the a.c. power line by a frequency control circuit. Built-in oscilloscopes in each camera control permit phasing to be checked. The 2-display monitors are at right angles to each other with a neutral beam-splitter mirror at 45° to each, so that the images appear to be in the same plane. The right and left eye images are presented by proper arrangement of polarizing filters for each monitor and by glasses worn by the observer. To minimize dosage and signal-to-noise ratio, the best compromise was a gating pulse of 4 ms (25 percent) synchronized with the vertical blanking signal of equal duration. This causes some decreased vertical resolution. The information was scanned off by the target beam in the remaining 75 percent of the duty cycle. Motion of the subject relative to the X-ray beam and detector screen provides useful fluoroscopic information about spatial relationships. It was interesting to add stereoscopy to information available from motion parallax alone. This system allowed collecting of comparative data on binocular stereo and "flat" fluoroscopy -- each with and without rotation of the test object.

Since this method is experimental, "engineering" and "human factor" performance tests were given to radiologists and control groups. Results have not been statistically evaluated, but they indicated that televised stereoscopic fluoroscopy provides a decided advantage in perception of depth over a non-stereo presentation. Previous experience or "immediate" learning improved individual performance. There was less hesitation by the individuals tested in recognition of patterns in symmetrical ("pseudo") stereoscopic presentation than in the asymmetrical one.

It seems evident that the advantages of stereoscopy would justify, for certain procedures such as heart catheterization, the necessary dose-rate increases. Our preliminary tests suggest that the addition of stereoscopy to fluoroscopy adds significantly to space orientation information available from motion parallax. Further study with statistical validation is needed to confirm this point. Evaluation for detection and interpretation will require clinical utilization.

7.30 Stauffer, H.M., Henny, G.C., and Blackstone, A.W. "Stereoscopic Televised Fluoroscopy," Radiology, Vol. 79, No. 1, pp. 30-34, July 1962.

Roentgenologists have been experimenting with stereoscopic fluoroscopes since the 1890's, but not until the development of the X-ray image intensification tube was it possible to overcome satisfactorily the problem of insufficient light. The introduction of television techniques made possible a televised stereoscopic fluoroscopic system and this report reviews one of a succession of such experimental adaptations.

Two conventionally housed X-ray tubes were mounted with targets separated 7 inches at 63 inches from a 9-inch intensifier tube, so that the X-ray beams were precisely coned on the input phosphor of the intensifier. The X-ray tubes fire on alternating half-cycles of the 60 c.p.s. power supply, and the intensifier tube output traveled through an 85mm ƒ1.5 lens to a beam-splitter which threw the beams alternately to two image orthicon cameras that presented them independently to two 8-inch television display tubes (525-line interlace). The cameras were pulsed to record for 2 milliseconds and to store the signal, so that with the two cameras operating 180 degrees out of phase, apparent right and left eye X-ray images were presented continuously to an observer wearing polarized glasses.

The system, as now constituted, has a strong ghosting tendency (carry-over from one eye to the other) that probably can be reduced to negligible levels through careful tube selection (below 5 percent). Light losses in the system are still above acceptable levels, however, except for a selected few applications. In fact, the contrast-detail visibility produced by the present image-orthicon, stereoscopic television system at 30 millirads per second is equivalent to that produced by the monocular image intensifier at only 5 millirads per minute.

7.31 Stevenson, J.J. "The Use of the Image Intensifier in Urology," *Proceedings of the Royal Society of Medicine*, Vol. 54, August 1961.

For more than 10 years image intensification has been used increasingly for X-ray diagnosis of deeply seated structures in the body. This technique eliminates dark adaptation of the eyes and subdued room lighting, and has effected less dose to patient, radiologist, and observers. Urologists, though aware of these and other advantages to their specialty, have hesitated to advise hospital authorities to spend large amounts of money on equipment that might have limitations. One disadvantage has been that the reflecting-viewer of the optical system of the type of intensifier most commonly used in England is cumbersome and the exit pupil of light so narrow that only one eye can be used for viewing. Too much room light causes detail loss and a special attachment is needed to accommodate more than one observer. The 5-inch diameter of the screens of early tubes covered only about 3 inches of kidney or bladder, which was barely sufficient. In 1959, when larger and more suitable tubes were about to appear, the hospital the author is affiliated with purchased its first camera chain and learned enough to facilitate installation of 7- and 9-inch intensifiers, added the next year.

The equipment consists of a small camera attached to the image intensifier, *two control units, and an 8-inch monitor, all accommodated in a movable console* cabinet. A 14-inch monitor has been fitted to a wall bracket, which is more convenient for viewing with the patient supine, and the hospital has been wired to allow transmission to the operating theatre, lecture room, or radiologist's office. The facility of comfortable viewing on the monitor and the ability to allow more detail by altering contrast at will have created so great an improvement that the staff is now viewing the televised image alone without cineradiography.

By means of the monitor in the operating theatre, the surgeon can see clearly the same clinical details as the radiologist. The dose to the patient is relatively low and rarely exceeds 1 or 2 r/minute. The staff has sought a method to use cineradiography without exchanging cameras or affecting the fluoroscopic picture. To film the monitor screen, a 2-speed synchronous motor has been attached to the 35mm cinecamera and a phase-shifting transformer constructed to prevent visible monitor bands on the film. The picture quality is inferior to that of the direct method, but the results are promising, and there is a considerable saving in dose.

The attractive possibility of electronically storing the televised image, that is, being able to continue to display it on a monitor for some minutes after the X-rays have been switched off, has long been envisioned. Thus, details could be studied at leisure and in consultation, without further irradiation of the patient, and without waiting for a film to be developed. Improved techniques undoubtedly will become available in the next few years.

7.32 Stevenson, J.J., and Ferguson, J.D. "The Use of Television in X-Ray Diagnosis," The Lancet, April 1961.

With the advent of the image intensifier, brightness was increased by 1,000 times or more, and fluoroscopy could be performed under normal, or subdued lighting, with no dark adaptation. Cineradiography then became usable in many specializations. It was valuable in angiocardiography, allowing as many as 30 or more pictures each second with relatively small doses of radiation to the patient, and in studies of swallowing, physiology of the renal pelvis, the ureter, and the bladder neck. In this country (England), it has not yet become routine for the gastrointestinal tract. The authors feel it is vastly superior to still radiographs or lectures for teaching body structures to medical students. The Royal Marsden Hospital now has a library of many hundreds of cinematographic sequences.

These methods do not permit demonstration of a technique or a lesion to a group at the time of examination. In 1955, the authors demonstrated an image intensifier in conjunction with an industrial television chain, and were able to show pictures of a patient swallowing barium. However, these cameras were not yet developed enough for suitable routine use. The industrial television chain using the vidicon tube is compact or portable and comparatively inexpensive. It is reasonably reliable and needs only occasional servicing.

The first permanent television installation at the Royal Marsden Hospital, in conjunction with the 5-inch intensifier, presented optical problems because the small output screen of the intensifier, recessed in a glass envelope, could not accommodate the fastest lens system. The staff modified the protective lead cone and could use two lenses of ƒ0.95 and ƒ1.3 with focal lengths of 25mm and 35mm, respectively. Although not ideal, it solved the problem until 7- and 9-inch intensifiers could be obtained. The 7-inch intensifier is particularly compact and accessible to large-aperture lenses. The 9-inch intensifier has an image distributor that allows a television camera, cinecamera, and optical viewer to be attached at the same time and sequentially brought into use. In practice, the staff finds this system too cumbersome, and usually uses a television camera only. The optical system is of large aperture. Besides reducing the skin dose, these large intensifiers cover a larger part of the organ being examined. However, with the greater amount of tissue irradiated, the integral dose may be increased. With cinecamera the quality of the picture is not as good as the intensifier screen filming, but it reduces the patient's dose by two-thirds.

All parts of the gastrointestinal tract can be studied by means of television, in most cases, with remarkable clarity. Radiologist and patient alike both appreciate the room light. The author and his colleagues still use "spot" films, which do occasionally show a small lesion not noticed on the television monitor.

7.33 Wachtel, M.M., Doughty, D.D., Goetze, G., Anderson, A.E., and Sternglass, E.J. "Image Intensification by Transmission -- Secondary Electron Emission," The Review of Scientific Instruments, Vol. 31, No. 5, May 1960.

A multistage image intensifier successfully employed a series of plane-parallel, secondary electron-emitting, thin-film dynodes to multiply electrons released from a photocathode. Thin layers of insulating material supported on conductive backings permit transmission of secondary-emission yields of 5-6 at accelerating voltages of 3 to 4 kv. with less than 10 percent of primary electrons penetrating the film. On image intensifiers of this type, cesium antimonide photosurfaces and dynodes are spaced .6 inches apart. The last dynode-to-phosphor spacing is 1.2 inches. A homogeneous axial-magnetic field of 400 to 500 gauss focuses electrons from various stages to an output phosphor. KCl dynodes were found to have limited life under bombardment and were therefore practical for certain specialties only. Tubes using freely supported Al-BaF_2 dynodes of .75 inches diameter and Cs_3Sb photosurfaces have been built. To obtain larger areas and to decrease damage, the dynodes were strengthened by a very fine wide-mesh reinforcement grid which does not detract appreciably from the image. It is believed that improved photosurfaces will permit amplification factors of more than 40,000 with only four stages of electron multiplication.

The compartmentalized construction of these tubes, with special care in cesiation of the photocathode, results in low, dark current. Flashes due to individual photoelectrons can be seen clearly as bright scintillations against a dark background. If the cathode is operated at ground potential instead of 16 kv. negative, breakdown light emission near the cathode is avoided and background reduced to about 40 flashes per second. At low light levels, resolution in photoelectron noise is limited. When fully developed, this tube is expected to be well suited to such functions as astronomy, nuclear particle track photography, X-ray fluoroscopy and spectroscopy.

7.34 Wallman, H., and Wickbom, I. "Roentgen-Television Equipment for Use in Surgery," Acta Radiologica, Vol. 51, 1959.

The usual aim of roentgenologic examinations is to obtain images of satisfactory contrast with as much detail as possible. In certain cases, as during surgical procedures, there is a need for rapid information, even if the roentgenogram shows only limited resolution. Here, fluoroscopy has advantages. It used to be employed for this purpose but was abandoned because the examiner's eyes had to be dark-adapted and because it involved radiation hazards. An image intensifier obviates the need for light adaptation and permits a dose reduction of about 10, but the examiner may still inadvertently come within the path of the rays. Most Swedish surgeons have therefore refrained from using fluoroscopy even with an image intensifier.

Our roentgen-television method conveys the fluoroscopic image to a television picture tube away from the path of the X-rays and enables the surgeon and radiologist to examine and discuss a relatively large bright television picture in an ordinary lighted room. The authors have been engaged for some time in developing this roentgen-television equipment for the operating room.

An X-ray image intensifier was combined with a closed-circuit vidicon television camera with ultimate image displayed on an ordinary television tube. The resulting scope of application is limited by the small field of view of this particular image intensifier and relatively low voltage and current from the X-ray unit, which precludes examination of thick parts of the body, such as the hip. In examination of the extremities the system has given encouraging results. The particular image intensifier tube used has its output screen placed in a deep tunnel necessitating an optical system of comparatively small aperture and therefore wasting a large part of the luminance amplification provided by the tube. It met aforementioned operating room requirements otherwise, and appears adequate for the reduction of fractures and nailing.

In considering combining image storage with fluoroscopy, technicians now realize that a fluoroscopic image never can display better quality than that permitted by the statistical fluctuations in the number of X-ray quanta effective at the fluoroscopic screen per picture element per 0.1 sec. Even unlimited brightness intensification still would require a certain minimum dose rate, which, in a fluoroscopic examination, sometimes has to be maintained as long as several minutes for detailed examinations. A very substantial dose reduction would be achieved by a storage system which "froze" the fluoroscopic image for subsequent study. Roentgenography provides such a storage system which permits considerably lower milliangstrom values than fluoroscopy. The value of an electronic system is in instantaneous image availability. Fractional-second X-ray exposure and minute-long electronic storage are inapplicable to the study of dynamic phenomena but workable with static phenomena, permitting a great dose reduction over ordinary fluoroscopy.

A new storage tube has recently become available. It has two electron guns, one of which impresses a charge pattern in a short time on a fine mesh at the viewing end of the tube. A flood gun then sprays a diffuse electron beam on the mesh, making a bright image visible which persists for 60 seconds, gradually fading. By pulsating the flood gun, storage time stretches to about 3 minutes, at reduced brightness. Resolution is limited by mesh structure, but 290 optical lines have been achieved across the diameter of the tube. Five distinguishable gray tones are reproduced. Magnetic shielding is critical and the tube is expensive but X-ray dose to the examiner is absent and to the patient is very small; image quality is at least sufficient for control of the reduction of fractures.

7.35 Webster, E.W., and Wipfelder, R. "Limitations of Combined Image Amplifier -- Television Systems for Medical Fluoroscopy." IRE Transactions on Bio-Medical Electronics, April 1962.

Limitations of image intensifiers in human fluoroscopic examinations include lack of physical freedom for the operator, restriction of image to only one person, and marked reduction of overall light amplification. Reproduction of the intensified image through television allows multiple viewing, freedom for operator, ready brightness, and contrast control.

The authors' experiments, a 9-inch intensifier with brightness gain of about 1,000 was used. Light was fed into a rotating mirror system with 90 percent of the light able to be supplied to television camera lenses or lens-mirror. Systematic and controlled testing was done to evaluate two general types of television systems -- the simple, compact, tolerant vidicon system; and the more complex, bulky, intolerant image orthicon system. Results, obtained under thick phantom conditions with all systems using the highest dose rates and stationary slides, indicate that the ordinary fluoroscope is the worst system, whereas the vidicon system, the image orthicon system, and direct optical viewing of the intensifier are the best. All performed equally well. The signal strength of the image orthicon presentations was considerably greater than that of the vidicons, but the noise was also greater. The more retentive image orthicons affected the visibility of moving images. At 2.5 millirads/minute, the orthicon performance is much better and reflects the greater stickiness of vidicons at low light levels. It would seem that the performance of the television and optical presentations is limited at present by quantum noise over a major part of the contrast-detail spectrum. The choice of image orthicon, relative to vidicon, for televised fluoroscopy would appear to depend on the dose-rate to the patient, which predetermines both the maximum possible picture quality and the presence of details moving with speeds in the region of 1 inch per second. At high dose rates, the best vidicon performed as well as the image orthicons for still or slow-moving images and was therefore preferable for practical reasons of size, weight, and economy, but for a high-quality picture with appreciable motion or a low-dose picture of inferior quality, the ultrasensitive image orthicon, which performs better under these conditions, was technically more desirable.

Research and Diagnostic Instrumentation

8.1 Bender, M.A., and Blau, M. "Photoscanning," Medical Radioisotope Scanning, 1959.

The high specificity of the thyroid gland for iodide ion permits satisfactory scanning with reasonably simple instrumentation, but most tumor scanning situations lack specificity of the tracer agent and lead to very low target/non-target ratios. Successful visualization requires collimation with sufficient depth response, resolution, and efficiency to maximize the tumor/non-tumor difference. The ideal collimator has a uniform response to tumor radioactivity, independent of the depth, a response achieved by coincidence counting of positron-emitting isotopes. The resolution of a collimator has a marked effect on the target/non-target ratio. If it exceeds the diameter of the tumor, the normal tissue contribution to the total count rate will increase without corresponding increase in the contribution from the tumor, thereby decreasing the target/non-target ratio. The detector must provide highest efficiency consistent with depth response and resolution for low dose of radioactive material to the patient. The 61-channel, 3-inch focusing collimator meets most of these requirements.

Data presentation should be capable of resolving small differences and should be understandable. Photographic recording is particularly convenient but must have high and variable contrast and variable gain. The authors' system utilizes the marked dependence of the light output of a tungsten filament on small changes in applied voltage. The pulses from a scanning scintillation probe are integrated by a count meter and the output of this instrument varies a resistance in series with a scanning light bulb with markedly nonlinear response. The resultant narrow range should not cause loss of significant information in brain tumor scanning, but is inadequate for scanning situations with larger variation in significant count rate, and provision must be made for lowering the contrast. This is possible by adjusting a second resistor in parallel with the primary resistor to obtain a family of contrast curves. With high contrast recording, a 30 percent change in count rate covers the full dynamic range of the film, from white to black. The light output must be adjusted to give minimal film darkening when the probe passes over normal tissue so that small increases in count rate over tumor areas will produce marked darkening of the film. With this system, however, 10 percent of the scans must be repeated because of improper adjustment of the gain control by inexperienced personnel.

A recent system to correct deficiencies has been used by permitting recording of all data on the film with fixed gain and contrast setting not adjusted to fit the variety of count rates and target/non-target ratios encountered clinically. The data are instrument-recorded on the film with minimal contrast and gain adjusted to use full dynamic range of the film to record activities from 0 to 1,000 counts per minute. The relatively low contrast film records all the data, but small differences in count rate cannot be distinguished by the eye. The processed film is then transilluminated by an X-ray view box and this, in turn, is viewed by an inexpensive closed-circuit television system. The televised image of the low contrast scan can be examined with extremely high contrast. Any 10 percent difference in film density can be presented as the full dynamic range of the television monitor, i.e., from white to black. This improved data presentation system has the advantage of high contrast for the visualization of small differences in count rate, and at the same time, records all the data.

8.2 Brown, M.C. "Preliminary Report on Biological Applications of Color Television," Science, Vol. 123, No. 3197, April 1956. p. 589.

Electronic image processing is an electronic way of seeing an object or process in its original or in a meaningfully altered form not normally visible by any other means. A test in 1955 of color television for this purpose in the biological area utilized the field-sequential color system. Microscopic circulation in frog mesentery and liver was observed in normal color relationships at satisfactory magnifications and with good resolution at considerably lower temperatures than are necessary for microcinematography. Electronic manipulation made possible the gathering of information not available through direct photography. Further applications with respect to correlating chemical data with living morphology were suggested by the extreme light-sensitivity of the color television system.

8.3 Chejfec, G., Danemann, H.A., Milewski, J., Texter, E.C., Jr., and Barborka, C.J. "Fluorocinematographic and Manometric Studies of Esophageal Motility in Patients with Achalasia," IRE Transactions on Medical Electronics, July 1960.

Achalasia is a neuromuscular disorder of the esophagus characterized by motor failure and having typical motility, X-ray, and intraluminal pressure patterns. No available method restores normal peristaltic activity, so the treatment consists of decreasing resistance at the esophagogastric junction. All the patients in the series were treated successfully by pneumatic dilatation. Formerly, the bag was placed in position under fluoroscopic control in the dark, but the authors now use the fluorocinematographic unit that operates under ordinary illumination.

A television X-ray system was used, constructed around a photoconductive camera. The X-ray image is directly amplified, eliminating scattering and low conversion efficiency. The recording camera of the television unit is synchronized to the image on the viewing kinescope. X-rays are produced in 1-millisecond bursts, using a dynapulse unit or a grid-controlled X-ray tube. Cinerecording was handled with a modified camera that picked up the image from the viewing monitor and from the oscilloscope simultaneously. The image brightness of the monitor screen is sufficient to expose film without increased X-ray dosage. Intraluminal pressures were recorded directly on heat-sensitive paper in addition to being displayed on the oscilloscope.

The major advantage of this system is its ability to provide a cinerecord without increased radiation dosage, increasing available time at least 25 times over other systems. Instant viewing, high response, and daylight viewing with unlimited availability of a permanent record are other advantages. Magnetic tape could also be used. Combining this unit with pressure-sensing devices allows correlation of radiographic and manometric data. Dense areas of the body do not yet lend themselves to this study method.

Mechanical problems are now being ironed out by the equipment manufacturer. The present method of superimposing manometric data on the cinefilm is not ideal. Nevertheless, knowledge and understanding of motor physiology of other portions of the gastrointestinal tract will be forthcoming as better equipment is developed.

8.4 Lewellyn-Thomas, E., Mackworth, N.H., and Howat, M.R. "The Television Eye Marker as a Recording and Control Mechanism," IRE Transactions on Medical Electronics, July 1960.

The corneal reflection that appears as a bright spot moving as the eyeball moves is used as the basis of the television eye marker. A television camera views the corneal reflection through a series of lenses and electronically mixes the position of the bright spot with the output of a second camera surveying the same scene the subject is studying. The result is a composite television image showing the scene with a bright spot superimposed on it. This eye marker indicates the direction of the subject's gaze from instant to instant. The sequence of eye movements can be analyzed by filming the monitor pictures and examining the film frame-by-frame to note successive positions of fixation. For long runs this is too involved a process, so a system has been developed to record raw data directly on punch tape.

Photocells are mounted on the face of the monitor screen so that when the eye marker moves across the screen, it activates the photocells. Each photocell represents a point of visual fixation in the matrix, and is assigned a symbol that is recorded when that photocell is energized. The output from each photocell is taken through an individual gating circuit to a common coding circuit that generates direct-current signals in the teletype code to operate a teletype printer-perforator. The resulting tape can then be used for computer analysis.

The photocell output can also be used for various types of feedback control of the information input to the subject, for diagnostic or therapeutic purposes. For example, by manipulating relative brightness and polarity of the scene, direct or peripheral vision can be tested. To investigate visual search patterns, dials on a meter board can be blacked out as soon as they have been read. Visual field defects can be mapped and therapy provided by using pleoptic exercises to develop correct visual fixation by exposing a visual stimulus only when the patient is correctly fixated. This fixation can be insured by having the photocell at the point of fixation control as the stimulus, so that it can appear only while the patient is correctly fixated.

In the investigation of saccadic eye movements (the rapid movements that occur as the eye moves from one fixation point to another, as in reading), the problem is to isolate the amount of actual perception during the movement, apart from peripheral vision during fixation. The television eye marker makes such an investigation possible by controlling the material through feedback. The photocell at the point of initial fixation on the monitor screen can suppress the material to be scanned until the eye movement actually has started, and the photocell at the final fixation point similarly can suppress the scanned information after the eye has swept over it; or the duration of the release can be controlled by the time-constant of the stimulus circuit itself. These uses illustrate only a few of the many applications in the investigation of man-machine situations in experimental psychology and in clinical ophthalmology.

8.5 Loeser, C.M. "Television Scanning Microspectrophotometry," Progress in Neurobiology, 1957.

An image orthicon camera tube picks up the microscope image directly without intermediate optics, is adjusted on the control monitor, and passes to the larger viewing screen. Repetitive scanning of a moving microscopic field results in a moving picture of the changes in light intensity present. Qualitative measurements are possible when a line-selector oscilloscope is attached to measure variation in light intensity by gauging relative pulse heights corresponding to relative darkness or lightness in respective areas. A recording camera can photograph both the screen and the oscilloscope at the same time to analyze pulses from moving objects by means of an electronic counter. The image orthicon camera with the line selector is by far the most versatile tool for analysis of moving microscopic fields, with greater sensitivity and resolution than photomultiplier tubes. It is linear with regard to increase in voltage produced by increasing amounts of light, which is very important in quantitative work with light absorption. It can also be built for ultraviolet or infrared work.

The easily handled vidicon camera is relatively inexpensive, but it sacrifices some resolution, sensitivity, and linearity. One should carefully pick a tube for linearity, use the best microscope available, and choose objects for viewing at least 1 to 1½ times the width of the scanning line. The vidicon tube will handle ordinary demands of microspectrophotometry very well, usind a monochromator and zircon or A-H4 or A-H6 type of mercury vapor lamp. Vidicon tubes can also be made sensitive into the ultraviolet. Video amplification may be needed to distinguish between pulse heights at different wavelengths when contrast changes only slightly.

Laboratory work in analysis of absorption and fluorescence has been done with acriflavine stained cells, and in every instance absorption analysis has proven more sensitive and easier to register on the devices used. The television method is an excellent data gatherer on cell characteristics such as nuclear-cytoplasmic ratios, presence and number of leukocytes, and number of malignant cells.

8.6 Mackworth, J.F., and N.H. "Eye Fixations Recorded on Changing Visual Scenes by the Television Eye-Marker," Journal of the Optical Society of America, Vol. 48, No. 7, July 1958.

Under laboratory conditions it is now possible to mark eye fixation by recording the successive positions directly onto a flat picture of the visual world. The problem of detecting the regions of the scene examined while the viewer scrutinizes a changing display has been met by two closed-circuit television cameras producing one composite picture. One camera presents the scene to the subject on one monitor and to the investigator on another monitor. The other camera picks up corneal reflection, which acts as an eye-marker of the region of regard, superimposing a bright spot on the investigator's monitor -- for visual inspection or motion picture photographing. Because the brain is involved, looking is not always seeing, but the eye-marker method at least reveals which of the many visual clues are being discarded.

The viewing of continuously changing scenes can be analyzed. The qualitative relationship between line of regard and particular aspects of the external world can be established without tedious computation, thus avoiding errors in calculations. A constant watch can be kept on where the subject is looking, which speeds up detection and correction of any recording artifacts and enables particularly interesting sequences to be filmed for future measurement. The corneal reflection method is more suited to testing large numbers of subjects than the more accurate procedures based on the use of corneal contact lens mirrors. All investigators have found that very small head movements can introduce serious errors into corneal reflection recordings, but use of a plastic mouth grip and head supports coupled with fixation by the subject on a central spot enables the investigator to verify lack of such movement during tests. In general, this technique has proved useful in experiments involving visual aiming, visual search, and thinking.

Visual search studies can analyze search patterns used by skilled industrial inspectors and people extremely able in flaw detection. Analysis of search situations has revealed that the subject can look directly at his object of search without seeing it. This method reveals the sequence in which the subject scans the separate symbols in a display and the time relationships between these shifts in gaze. It is possible to record the input selected by the subject from the vast complexity of his visual world when he is thinking out the answer, or a series of answers, to certain intellectual situations. Eye movements are important to comprehension during such tasks as reading static printed material. In sequential decision situations, such as landing an airplane, equipment has now been devised that not only records the eye movements, but also shifts the apparent visual field in reaction to the selected input from which the subject makes decisions regarding the task.

8.7 Montgomery, P. O'B., and Hundley, L.L. "The Use of Television and Scanning Techniques for Ultraviolet Irradiation Studies of Living Cells," IRE Transactions on Medical Electronics, July 1960.

As early as 1912, an ultraviolet microbeam using refracting lenses was devised for irradiating selected areas of living protoplasm. In 1956 the ultraviolet flying-spot television microscope became a new tool for studying ultraviolet radiation. It uses an ultraviolet emitting flying-spot scanner tube that allows a 250-line raster to be traced on the cell at variable speeds. The image of the raster is reflected in reverse through a microscope. The unabsorbed energy transmitted by the spectrum strikes the surface of an ultraviolet photomultiplier tube, and the resulting current generated in the tube modulates a monitor tube synchronized with the ultraviolet flying-spot scanner tube. The absorption image of the living specimen is thus traced out on the monitor tube. It may be recorded by time-lapse motion picture photography.

Modifications of this basic equipment have provided a technique for spot-irradiation of a specimen. Horizontal and vertical sweeps are fed to generators that vary delay and pulse width. Pulses are then compared in a coincidence circuit whose output modulates the scanner tube grid, causing an intensified spot to appear on the scanner tube. The spot can be moved or varied in size down to one picture element.

Simultaneous viewing of the specimen in visible and ultraviolet light is now possible by masking off opposite halves of each raster and bringing the remaining output into optical registration. The ultraviolet half of the horizontal scan in the focal plane and the visible light half scan the same area, and the monitor tube displays the two images in a side-by-side presentation. Danger of overloading the video amplifier in the intensified area and of ultraviolet damage have been overcome by applying a pulse of opposite polarity from that applied to the ultraviolet to the visible light tube. The two rasters were brought into optical registration that allowed the ultraviolet background to be at zero level and the background simultaneously filled in with visible light of the same intensity as the spot. The video system could then be adjusted to the proper viewing level.

8.8 Smyth, C.N. and Sayers, J.F. "Ultrasonic Image Camera," The Engineer, February 1959.

With the ultrasonic camera, visual studies can be made of internal structure of objects transparent to ultrasonic waves. This equipment is complementary to X-ray and ultrasonic pulse-echo inspection methods. The object to be examined is immersed in a continuous-wave, ultra-sound field, and forms an ultrasound image of diffraction pattern on a single piezoelectric plate that becomes the end-wall of face of a scanning electron tube, similar to a television camera. The ultra-sound vibration image falling upon the camera face produces a corresponding alternating piezoelectric voltage distribution, the magnitude of which is read off, point by point, by the scanning electron beam. At each point the camera provides an output current proportional to the incident ultra-sound intensity, which, after amplification, modulates the brightness of a television reproducer scanning in sympathy with the camera. The ultra-sound "illumination" is switched on for alternate frames only. Between each, the charge distribution changes on the quartz. The picture can be reproduced repeatedly, and moving objects can be followed.

The ultrasonic camera is simple to construct, as it comprises only a 4.5 cm. diameter, glass-envelope fitted at one end with a cathode-ray tube gun and zirconium getter wire, and at the other end, an ion-trap gauze and quartz plate cemented to the glass. The camera material chosen had to be non-porous and strong enough to withstand temperatures of at least 200° Centigrade during the manufacturing process. Sound levels are low enough not to damage biological tissue. The Q-factor of quartz damped on one surface by a liquid is reduced to about 18, where there is little loss of image resolving power from multiple internal reflections. The instrument has been used only with perspex and polystyrene lenses in water medium.

The camera-sensitive surface is limited in size by its ability to withstand atmospheric pressure, although developments are underway that may overcome this limitation. The practical medical value of the ultrasonic camera is not yet determined. It avoids the dangers of radiation methods, but larger cameras are necessary for many useful applications. It holds promise for better inspection of soft body tissues, masses in abdomen or breast, for watching the foetal heart during labor, and for investigating growths near the radiation-sensitive gonads. Once the instrument becomes available as an industrial tool, it may well find further applications.

8.9 West, S.S., Loeser, C.N., *and* Schoenberg, M.D. "Television Spectroscopy of Biological Fluorescence," *IRE Transactions on Medical Electronics*, July 1960.

Fluorescence can offer sensitive information about the concentration and physico-chemical state of intracellular components which interact specifically with fluorochromes. Many fluorochromes may be excited at radiation wavelengths not directly lethal to the cell. The intensifier-image orthicon television tube expands the previous limitation of rapid decay of fluorescence under radiation. It records the fluorescence spectrum rapidly from a single cell stained at dye concentrations approximately 1,000 times less than previously possible.

A "high power" prism monochromator between microscope and camera is optically efficient. A blue filter at the lamp diaphragm absorbs light at the wavelengths of fluorescence emission. The microscope ocular was removed and the image focused on the ground-glass screen of the monochromator, the entrance slip of which acts as an aperture stop in the optical system. The image of the split is uniformly illuminated, and can be closed to the limit set by the camera tube sensitivity while still accepting light from the whole cell. A filter between microscope and monochromator absorbs the exciting radiation to avoid a large amount of scattering within the intensifier section of the tube that would make it impossible to record the fluorescence spectrum. The exit slit of the monochromator was removed, the whole spectrum brought to focus on the face of the intensifier image orthicon by an auxiliary lens, and displayed on a standard television monitor.

The oscilloscope delay circuit selected one television line passing through the spectrum image that was displayed on the oscilloscope and photographed. The line selector display was calibrated to wavelength along the horizontal axis by using the lines of the mercury spectrum. The mercury arc lines served as fiducial points on the line selector photographs for the complete wavelength scale peculiar to the monochromator used. Fluorescence emission spectra were recorded from 17 single ascite tumor cells stained with acridine orange solutions ranging in concentration from 3.3×10^4 molar solution to 3.3×10^7 molar solution. Two peaks were observed, one at approximately 540mμ and one at about 640mμ The long wavelength peak varied markedly with change in concentration of the staining solution, but the short wavelength peak did not vary.

Acridine orange (AO), used to stain nerve cells in concentrations as low as 10^4M, is toxic only upon illumination of the culture. This is strongly indicative of photochemical damage in the presence of AO. Since the damage varies directly with solution concentration and intensity and duration of illumination, it is biologically important to work at minimum concentrations and with short exposures. AO-stained tumor cells showed that with increasing concentration, nuclear chromatin fluorescence changes from green to yellow and the cytoplasm from dull green to orange. Since several attempts have been made to utilize these colors for differential diagnosis of malignant states, an appraisal of their meaning in physico-chemical terms adds significance. *In vitro*, RNA-AO and DNA-AO complexes cannot be differentiated by means of absorption of fluorescence spectra, except fortuitously, and elements responsible for the orange color are partially undetermined. Absorption measurements already reported and fluorescence measurements reported here on ascite cells provide spectra closely agreeing with *in vitro* data. Results of these experiments are only one example of possibilities to be derived from the type of instrumentation employed.

8.10 Zworykin, V.K. "Television Techniques in Biology and Medicine," Biological and Medical Physics, Vol. 5, 1957.

After describing broadcast and closed-circuit television, the vidicon camera, color, stereo, and flying-spot television in some detail, the author discusses the instructional area where public health broadcasts have been carried by commercial and educational stations. Some open-circuit programming has been carried for doctors. Recent advances in medical knowledge have been carried by closed-circuit commercial networks. Most use of television has been in surgery, which requires careful planning and production to maintain student interest, and in microscopy. Black-and-white TV has been used successfully for teaching dental surgery throughout the country.

Television has had valuable research applications. In psychiatric and psychological research, it allows group behavior studies of children and student familiarization with methods of dealing with patients. In microscopy, television increases ease of viewing, contrast, and spectral range of illumination. It facilitates quantitative measurements of light absorption and light emission, valuable for work on living cells. The ultraviolet-sensitive vidicon permits continuous observations of specimens with the advantages usually associated with a staining and fixing, but without the usual side effects, although care must be used to avoid lethal dosages. Color translation microscopy utilizes the differential absorption rate of different components of the specimen by using three primary colors and selected wavelengths superimposed to form an image. It eliminates time-delay and costs associated with photographic processes.

Television has been used for area display of skin potential. Of necessity, it is a very crude representation because the input signals are too low for wide-band transmission, but significant sources of potential variation are far enough from the point of measurement that a fine-grained representation would gain little information. Area displays for the localization of brain tumors have been suggested. An electronic commutator has been used to apply signals from 16 electrodes on the chest of the patient to the grid of a cathode-ray tube to produce a pattern for observation or photographing. Other methods of connecting electrodes are in use.

Television surveillance can help limited hospital staffs use time more efficiently and minimize hazards of highly contagious areas or radiation, etc. In fluoroscopy, with reduced radiation and elimination of dark adaptation, the basic problem of insufficient brightness of the ordinary fluoroscopic screen is solved. Penetrating radiation is well applied to cancer therapy with a TV camera and image intensifier. With the scintiscanner it is possible to map distribution of radioactive materials in organs after administration to the patient. Television instruments for particle counts include the iconumerator in which a 1,000-line scanning pattern formed on the screen of a flying-spot scanner tube is projected on the specimen, and the sanguinometer, which counts red blood cells using a television microscope with an auxiliary counting circuit. An instrument that measures cell absorption, the cytoanalyzer, follows previously set outlines to chart a series of dots on the screen as normal or questionable, so that a cytologist need only check the questionable samples. These examples indicate that one can be confident that television will take over many routine tasks in the fields of medicine.

Surgery

9.1 Douglas, A. "Closed Circuit Television . . One of the World's Greatest Tools in Surgery," *World Medical Electronics*, Vol. 1, No. 1, September 1962.

Heavier demands on the medical profession call for more precise diagnosis and more accurate and swift treatment. Whereas dissemination of knowledge in other sciences has multiplied enormously because inanimate objects are used for teaching, a peculiar intimacy exists in medical science, both in the kinds of manipulative skills employed and in the relationship between patient and doctor. No record remains beyond living testimony. This limitation has always hindered widespread instruction, but the need for more trained medical men has led to the devising of many ingenious aids to learning. Advances in the use of body-measuring devices have allowed some permanent records to be made, but the problem still arises of showing actual use of apparatus to more than one or two selected observers at once.

Until recently, motion pictures have provided a permanent record and large-scale instruction, but film as a teaching aid does not create the feeling of intimacy between teacher and audience. In the waiting period while film is being processed, much of the effect of personal powers of the surgeon is lost. Discussion is impossible. With television, complete control can remain in the hands of the teacher.

Two types of color camera are available: the image orthicon, suitable where illumination is not great; and the vidicon camera, which is smaller, cheaper, and more convenient to operate. The latter is less sensitive and requires roughly twice the light intensity. Image tubes cannot be pointed downward without risk of tube damage, and it is therefore advisable to view the subject matter through a mirror placed above and at a 45° angle to both camera and subject matter. This further insures that the equipment is out of the way. Furthermore, the television camera is silent. A commentary may be transmitted by conventional microphone. Because of the need to capture full shadow detail, highlights should be restricted. Light gray clothing, and pink, green, or gray surroundings help reduce halation. Rapid movements should be avoided.

While the teaching and demonstration of surgery is the most important application of closed-circuit television, camera tube properties provide unique opportunities for certain other applications, such as examination of skin structure by infrared light, which is invisible to the eye but faithfully transmitted by infrared image tubes. The electron microscope may be fitted with an image intensifier tube, permitting more brilliant and better resolved pictures to be fed directly into the television circuit. The intensifier tube uses less ultraviolet radiation than photography, so that delicate specimens in the microscope will be less damaged. Since intensity depends on the strength of the electron beam, it would be impossible to view many specimens any other way.

Television also facilitates simulation of incisions in plastic models of internal organs, safe observation of infectious cases, and observation of bodily reactions in unusual circumstances, such as in centrifugal machines used for conditioning personnel for space vehicles. The fact that all this information can be stored and used again at any time, even in color, on videotape dissipates the sole advantage of motion picture film, while adding the inestimable gain of viewing the action at the moment of occurrence -- raising closed-circuit television to one of the world's greatest tools in surgery and manipulative medicine. Although commercial color television transmissions are not yet regularly available, closed-circuit apparatus can be bought now.

9.2 Feindel, W., and Schneider, R. "Closed Circuit Television in Electrocorticography," Electroencephalography and Clinical Neurophysiological Journal, Vol. 12, No. 4, November 1960.

To meet a space and structural problem, the authors set up recording apparatus in a room next to the operating room and fixed a camera above it to operate remotely from an adjacent console (motor-driven lens focusing) in a 525-line, 30-frame interlace system, feeding both the monitor and a 21-inch receiver mounted at eye level on the instrument cart that holds the stimulation unit in the operating room. Two-way audio was employed. The system is operated by the electroencephalographer. If necessary, a second camera could be installed to cover the surgical field. This system makes it unnecessary for the electroencephalographer to enter the operating room, and provides the surgeon with a 3x magnification of the continuous record on the 8-channel recorder.

9.3 Geissendorfer, R. "Colour Television Relays of Operations," Medica Mundi, Vol. 8, No. 2, 1962.

Demonstrations for teaching, lectures, and meetings progressed from maps, to projected pictures, to black-and-white and color transparencies, and finally, to black-and-white television. Viewing domes for watching surgery required elaborate architecture and did not provide adequate visibility. Color television provided decisive change, with true color, excellent plasticity, and brilliance of picture. Relays from the operating theater to greater distances are now possible. There is no longer interference with asepsis or obstruction from spectators. The only drawback of color television is its high purchase price, but this is expected to drop in time. Pictures are shown on monitors, or are projected to several hundred people, as required. Great magnification gives details almost more clearly to the audience than to the surgeon himself.

In Europe, there are two different types of color installations. The surgical clinic at the University of Frankfurt uses one of these, which excels because of perfect definition of picture and natural color reproduction. The other process, however, permits projection from longer distances on larger screens.

A monitor in the surgeon's field of vision permits adjustment and control of the viewing section desired. The pickup camera and operating lamp have a common ceiling-suspension, so that the camera does not obstruct routine operations. A special lamp was built with reinforced suspension. A mirror below the lamp picks up the pictures of the operation, which are directed into the camera lens and passed by cable to the relay apparatus. Remote control of camera adjustments and zoom lens are used. This system does not require a specially trained technician, and can be controlled by one of the doctors. No manipulations of the pickup camera need bother the operating team. There is an intercommunication system among the surgeon, lecturer, and doctor controlling the apparatus. No special maintenance is required, and this system has proved extremely reliable during 1 year of use. Aside from its proven usefulness to surgical training, scientific meetings, and postgraduate training, this new medium permits considerable simplification in architecture, as compared to the viewing domes still generally accepted.

9.4 Hague, J.E., and Crosby, E.L. "Television: Newest Aid in Teaching Surgery," The Modern Hospital, Vol. 70, No. 4, April 1948.

Various approaches to teaching surgery have been unsatisfactory. Overhead galleries are expensive, and mirror-refracting viewers of the operating field have not had great visibility. Visibility has been limited to a few people. Additional observers in the operating room add to concern for safety.

The first televised operation occurred in February 1947 at The Johns Hopkins University. The camera was securely bolted to a rack over the operating room light trolly, and an additional camera was in the gallery. The second camera did not produce worthwhile images. A microphone was above the operating table, and control equipment was in an adjacent room. Five operations were televised before the equipment was dismantled 3 days later. The image was channeled through cable to 10 television receivers in 3 rooms, with a field of view 8½" by 11½". Each step in the operation was clearly recorded by television, and the surgeons explained what they were doing. The surgeons experienced little or no difficulty working under cameras.

A conference was held to discuss the advisability of installing television equipment in two new operating rooms. Cost was estimated at $17,000 for camera and control equipment, $350 for each receiver. For two operating rooms, the camera and control equipment would cost $25,000, because some duplication could be avoided.

The chief engineering problem was lighting. The overhead light was not powerful enough for required detail, and an additional spotlight was used. Permanent installations should not require additional light sources. There appeared to be no insurmountable obstacles to a permanent setup. Television, while not the whole answer to graphic teaching of surgery, could solve many problems. The two operating rooms now in the final stages of construction will be readily adaptable to television. A recessed metal channel in one wall of each room can hold 25 feet of cable, providing an unbroken connection from the camera to an outlet beyond the explosion hazard area. Built-in conduits extend to the observation room above. The new light has a specially ground mirror for optimum image of the operating field. The camera can be placed on a platform, focused on the mirror, to send the image through the cables to the control room, thus eliminating the camera hanging on the light fixture. It seems important that the audience for televised surgical procedures should be limited to those with a bona fide professional interest. This can be done by cable transmission within the hospital or by special microwave frequence of very narrow beam.

9.3 Klein, M.D., Ruhe, D.S., Hanley, E.V., Penniston, L.M., and Maloney, W.R. "A New Dolly-Boom and Light Complex for Medical Color Television," Research File, Vol. 3, No. 6, 1960.

A single color-camera usually must suffice for the many demands of a medical center. Equipment must have great mobility and intrinsic facility. For the teacher the television studio has become a classroom and laboratory, one that usually must subsist with the simplest and lowest-cost camera systems and fewest possible operating personnel. Color cameras, which are larger, heavier, and more expensive than monochrome cameras, must meet these same criteria.

An equipment manufacturer designed for the authors a large, mobile dolly-boom that swings its field-sequential color camera vertically over an operating field. It was cumbersome, but effective. Its use for operative surgery was facilitated by a commercially developed, controllable mirror on a long boom arm. A smaller boom-arm mirror system has been developed for monochrome vidicon cameras by the National Naval Medical Center. Unfortunately, it was impossible to escape the bondage of a single operating room with this camera on its huge studio dolly.

For the 3-vidicon color camera a new, highly mobile, multifunctional dolly-boom was developed. Although it requires 8 square feet of floor space to counterweight a 40-pound camera and light fixtures suspended from a boom arm of 60 inches maximum extension, the unit appears to realize the possibility of color television throughout a compact institution. It can be used in almost all elevators, and fits through almost all doorways and corridors. It can deliver on-the-spot pictures from any location. Its flexibility allows unlimited camera angle. A duplicate control panel is provided on the dolly base for setup; a 14-inch monitor on a high stand guides the demonstrator; and there is a complete remote-control console for program pickup. Original development costs of $7,500 could be reduced radically with the production of additional units. Disadvantages include high cost, size, and cumbersomeness. With smaller and more sensitive color camera development, the principle of a mobile, overhead camera carrier may become a realistic possibility for wider utilization.

A superabundance of light has so far been necessary to overcome problems of tube sensitivity, lens speed, and need for maximum depth of field. The field-sequential color camera at the hospital the authors are affiliated with sacrifices light because of its color drum. The 3-vidicon color camera they have requires a great excess of light beyond the needs of the human retinae of surgeons and demonstrators. In addition, the light must be essentially heatless for the surgeon's comfort and patient's tissues, and it should be possible to focus it over a range of perhaps 30 to 60 inches from the camera lens.

While aware that lighting experiments were occurring in other locations, the authors nevertheless undertook development of a new working light. As now constructed and modified, this light consists of a cluster of coaxially adjusted, sealed-beam, airport marker lamps, fixed to a frame and simultaneously controlled by a ball-bearing focusing ring that encircles the lens turret of the camera. The flat field light is limited to an area not much larger than the primary field of a single lamp. The Kansas University light that the authors developed, with its present choice of sealed-beam lamps, is limited to uses that require intense light concentrated on a small field, such as the surgical wound, but allows optimal camera movement. Floods must be added to fill in fields of larger dimensions.

9.6 McCarthy, H.H., McGuire, L.D., Johnson, A.C., and Gatewood, J.W. "Television in Medical Teaching," Hospital Progress, Vol. 29, January 1948.

Visual impact is particularly important in medical teaching. Television would allow such teaching without crowding many students around the bed of a sick patient or into an isolation ward, and demonstrations would not have to be repeated, as they are at present.

To check out the teaching possibilities of television, two remote-controlled image orthicon cameras and related equipment were recently borrowed from the local television station and set up in an operating room at Creighton Memorial St. Joseph Hospital, in Omaha. One was suspended immediately above the operating field, and the other was placed in a pivotal position at the side of the room. A microphone suspended over the operating table carried commentary to the closed-circuit audience in the auditorium next door. The anesthetist demonstrated his technique; the surgeon discussed his procedure; and the radiologist gave historical, comparative information in relation to the procedure, while the pathologist displayed the specimen and discussed other pathological lesions. After the operation, postoperative treatment was reviewed by one of the surgeons. The television viewers were impressed by clarity of projection on five receivers, depth and perspective of the pictures, distinctness of the voices, and the thoroughness of the presentation.

Television is superior to motion pictures by virtue of the immediacy of watching an actual operation in progress, and while color is not available, black-and-white pictures transmitted by the latest equipment, are very satisfactory. At present, however, installation costs are somewhat prohibitive. Nevertheless, postwar building plans for teaching-hospitals should make provision for television in the surgery department and teaching wards, especially the isolated and infant wards. Conduits for coaxial cable, if not the cable itself, should be installed, and room ceilings prepared for cables. A suitable location for control units should also be considered. Building committees would do well to consult manufacturers for specifications. Since medical television is closed-circuit, and unavailable to the general public, the patient's privacy remains intact, and he is also protected from possible disturbance and contamination.

9.7 Rousselot, L.M. "TV in Surgical Teaching," Hospital Progress, Vol. 35, October 1954.

The new operating room television equipment at St. Vincent's General Hospital in New York City is the first of its kind in a voluntary general hospital. Three major operating rooms have been equipped to televise surgery in progress to surgeons, house staff, and nurses on any of nine screens outside the operating rooms. Audiences of any size may see an image enlarged up to twice, and listen to the commentary by the operating surgeon through the small microphone in his mask. A 2-way hookup makes it possible for him to hear and answer questions relayed by the second member of the teaching team in another room.

The initial expense of the installation is compensated for by great space-saving, through eliminating the gallery, while increasing the number of spectators. The hazard of airborne infection associated with additional personnel in the operating room is also eliminated.

The television camera is mounted in the center of the 4-light fixture above the operating table, and is remotely operated and focused by a technician in the adjacent control room, who observes the scene on a monitoring screen. Remotely controlled television eliminates the difficulties associated with cumbersome and space-consuming motion picture cameras and crews, and the heat of their special lights. It also does away with the constant shifting of apparatus, which interferes with the smooth functioning of the operation.

9.8 Ruhe, D.S., and Klein, M.R. "Television of Operative Surgery," Medical & Biological Illustration, Vol. VII, No. 1, January 1957.

The amphitheater has been abandoned for surgical teaching because no one could see the procedures, and for pathology teaching, because of the threat to aseptic routine. Television appears to offer a new way to teach these procedures. The Kansas University Medical Center explored color television extensively, first with programs delivered from the operating room to a remote classroom, but since 1954, with the audience in the gallery of the operating room, so that everyone in the living clinical surgery group has the visual vantage point of the surgical first assistant.

A course to present improved techniques to busy general surgeons was devised. A surgical gallery classroom seating 26 was outfitted for television, and an adjacent classroom was equipped for discussion. Audio-video transmission was also relayed by microwave to the Veterans Hospital 7 miles away, and additional receivers were occasionally placed in another Medical Center classroom. A field-sequential color camera was mounted in the light-bracket above the operating table. A remote-controlled turret offered 90, 135, and 229 mm. lenses. Two 10.5-inch color receivers with magnifier bubbles were placed in the gallery, and a monitor showed the operating surgeon what his audience was seeing. A microphone hanging above the operating field and a chest-microphone for the instructor in the gallery provided audio pickup for the distant points. Facilities were also provided for slides, motion pictures, and X-ray viewing in the gallery.

Five surgical clinics were held. The staff supported guest surgeons in selecting and preparing patients in the operating theater and in discussion at the operating table. Live television was used almost continuously during surgery, and the interplay between instructor above and surgeon below was provocative and important to the maintenance of interest. Participants indicated that the experience was so worthwhile they wished to register for a new series, when responding to post-session questionnaires. Makeshift gallery seats of foam rubber over wooden benches were distracting, as were the television crew, individual needs of each surgeon, the sameness of long sessions, and a phenomenon that might be termed "televisionitis." The audience, composed of general surgeons who had themselves performed the same type of surgery, preferred to have the guest surgeon operate and teach at the same time. Secondary classroom audiences were distracted by discontinuous vision and constant sound as long as the group was in the operating suite, but they were entirely out of contact when sessions moved to the adjacent classroom.

The general surgical staff is accustomed to television-mediated surgery and its special disciplines, but it is not easy to organize a full day of demonstrations and to procure able men who will participate in such extremely challenging teaching. Problems remain to be overcome, such as greater magnification, lens-centered surgical lights, large-screen color projection for the amphitheater, and a mobile camera mount.

A limited trial of both black-and-white large screen projection and color proved unsuccessful. A subsequently constructed mobile dolly has increased the range of surgery that can be taught. Flexible time limits please the staff. Films, other than those brought by the lecturer to illustrate variations of the live approach, lose the sense of intimacy and immediacy essential to surgical teaching. Television appears to have become an extension of the personal powers of the surgeon-teacher in this series of clinics, and supplemented by his slides and motion pictures, has evoked deep responses from his students.

9.9 Schafer, P.W. "Television at the University of Kansas Medical Center," The Journal of the American Medical Association, Vol. 152, May 1953.

The University of Kansas School of Medicine received an appropriation for television from the Kansas legislature in 1949. The school administrators gave the department of surgery the responsibility for implementing this program. It was difficult to secure usable equipment, but a monochrome single camera chain was installed in one of the operating rooms at the Medical Center. Since this camera used a vidicon tube, it could be mounted vertically above the operative field. This position still appears best, especially now, with remote positioning controls.

Television was used originally only to instruct 3d-year medical students assigned to surgery because the Medical Center felt it had to be well evaluated before changes were made in the instructional program. Faculty and student reactions were favorable, but monochrome television was too limited. A color camera chain was installed in 1951. Color conversion presented many academic advantages, but posed new problems, many of which are still unsolved. The color camera uses the highly sensitive image orthicon tube, and cannot be mounted vertically or left stationary on a brightly illuminated scene for more than a few seconds without damage. A replacement tube costs $1,200. Fortunately a light was designed that allows horizontal camera mounting, and a mechanism was designed to position the camera remotely. Because of technical operational difficulties, adequate planning for engineering and technical staff should precede equipment purchase

In new building construction, it should be remembered that a camera for surgery can be mounted in a room with sufficient ceiling height to accommodate any major operating room light. Television observation surpasses that of any gallery, a fact which suggests that few new hospitals need to construct costly amphitheaters. The control room should be as near to the center of all camera locations as possible to avoid distance problems. Correct estimation of conduit sizes involves distances to be covered, number of junction boxes, amount of angulation; but an overestimation of at least 30 percent is recommended for later, likely changes. A major problem arises if all slave monitors or viewers are not aligned in series on the conductor. For parallel transmission of video signals, a distribution amplifier must be interposed between the video distribution system and master monitor. In multicamera installation, however, simultaneous transmission of different programs to different distribution areas is allowed by parallel transmission. A generous number of outlets should be provided in the control room and receiver locations, and should be wired directly enough to preclude sharp voltage drops caused by the intermittent load of other hospital equipment. To solve ground-current interference in the signals, the Medical Center has prevented grounding of the shields in conduits. A balanced line distribution will also solve the problem.

At present, the Medical Center believes that good programing with a single camera chain requires four persons at least -- one electronics engineer, two electronics technicians, and one program director to coordinate and act as liaison person among everyone involved. A program director is as essential in academic television as in commercial shows. Unimaginative programing is certain to fail in its purpose.

The Medical Center's efforts should be regarded as investigatory. At this early date information is too incomplete to reconcile expenditures on a cost-product basis. The Center feels, however, that this medium will withstand future critical scrutiny.

9.10 Schafer, P.W. "The Kansas Television Experiment," *The Journal of the American Medical Association*, Vol. 152, June 1953.

The original 1949 monochrome installation that was replaced by color television in 1951 is under the administration of the department of surgery. Television has been possible without budgetary support outside the University. The Medical Center did not intend to substitute television for student participation, but did feel, mistakenly, that success consisted of combining a camera above an operating table with a surgeon's commentary, without classroom discussion. Attendance at simple operations was compulsory for students, but elective for major operations. At first, student interest was high, perhaps because of the novelty, but just as the student is bored standing at the operating table holding retractors instead of participating in more challenging opportunities, so did he spend less time in the elective television clinics, although more could be seen on television than in the fourth position at an operation.

While waiting to replace monochrome with color equipment, The Center reevaluated programing and concluded that it was wasteful to simulate endless stands at an operating table; that the instructor had to be physically present in the classroom; and that television, to be effective, required short sequences and salient aspects of topographic and regional anatomy, normal and abnormal physiological processes, gross pathological conditions *in situ*, and certain details of the operative procedure itself. These concepts posed problems. A full-time surgical faculty of only 14 meant that each man would have to plan an integrated program once each 2 weeks. Planning includes patient selection, time and place of operation, arrangements for visual aids. The Center was to have only one camera chain, but wanted to include other clinical and basic science faculties in the program, coincident to its attitude of breaking down rigid departmental lines in the teaching effort. It decided to avoid long, disorganized, uninspired television, and concentrate on the best possible 1-hour performance. Attendance was obligatory. On implementing these ideas, the Center received almost unbelievable faculty cooperation. Emphasis was shifted from the operating surgeon to the classroom instructor, since he is the logical person to control the session. Surgery seems a logical starting point for such a program because of the inherent presence of discipline and recognition of direction and authority of the surgical team. Once the ideas were implemented and the staff was faced with huge planning problems, everybody agreed that it was imperative to obtain a professional program coordinator.

At present, 35 carefully selected basic subjects are presented to the surgical externs for planning. Each faculty member delegates whatever he wishes in conference with the program director, a week or two in advance of presentation. A rough outline is made, visual aids or equipment determined, and participants' roles are identified. The program director then becomes acquainted with the subject matter and coordinates technical and professional personnel. On the day of the scheduled class the director is the sole authority; otherwise all planning would have been useless.

Although color television is still to be improved, the Center's system can produce an entirely adequate image with remarkable fidelity of color and detail. Also, students have a better view of the operative field than the operating surgeon. It is still too early to contemplate a cost-accounting analysis but it seems a safe assumption that a new hospital can substitute this new medium for costly observation galleries. Operating budgets are not yet clear, but it is believed that the scope and quality of the results will justify the expenditures. One of the undeniable values of live television is its sense of immediacy. There is basic dramatic appeal when a live patient actually is being operated on, and a sense of intimacy establishes sharp rapport between the operating room and classroom. The 2-way audio system and video identification of the operative field in the darkened classroom give an impression of being closer to the surgical field than when actually at the operating table. Lack of distraction probably contributes to this sensation. Each teacher has his own planning procedure, as he prefers, and the Center feels that any policy that dilutes the concept of personalization, probably should be avoided. The teacher has flexibility in showing as much, or as little, as he wishes of a program. Initial and continuing costs prevent each individual department from having its own installation, and the resultant necessity of working together erases departmental lines. This represents a solid asset of doing away with rigid departmental barriers.

Experienced television teachers at the Center prefer to redo live telecasts rather than use a kinescope of their own previous program, even if these are available. The Center intends to keep exploring the potentials of television; the many new challenges, such as those posed by affiliate hospital and interschool programing, development of the academic television studio, and color kinescopic recording.

9.11 Trimble, I.R., and Reese, F.M. "The Use of Television in Surgical Operations," Bulletin of Johns Hopkins Hospital, Vol. 81, September 1947.

Demonstrations of surgical operating techniques were unsatisfactory because observers did not have a good view and also brought contamination into the operating room. The idea of televising newer surgical techniques was conceived at The Johns Hopkins University in 1947, for presentation to 750 members at the annual meeting of The Johns Hopkins Medical and Surgical Association.

A device was constructed to hang the camera from the central overhanging light fixture in the operating room. Two temporary single-phase circuits were installed for the camera and transmission, and for the projectors. Five operations, four on the heart and one on the sympathetic nerve trunk of the vertebral column, were transmitted to 10 television receivers in 4 different classrooms, with the surgeon simultaneously describing each operation and being heard through a speaker system. Two cameras, prepared and tested beforehand, were in constant use. The operating room camera was sharply focused for an exceptionally clear image, and each step in the operation was clearly recorded by television. The pictures were black-and-white. The second camera, in the gallery, showed a general view of the activity in the operating room. The control room flashed these pictures on the projection screens, alternating with the first camera.

It is believed this experiment proved conclusively that demonstrations of, and instruction in, surgical operations to a group of more than three people can best be accomplished through television.

Miscellaneous

10.1 Berci, G. "Medicine and Television," The Medical Journal of Australia, December 1961.

Television allows demonstrations of small fields to groups of students within a classroom or in different parts of a building. In postgraduate teaching, television can overcome barriers of time and distance to allow contact with specialists. It should be possible to use almost any type of teaching technique for viewing at home at a convenient time, with telephone contact available during the telecast lecture. An open-circuit medical telecast would have to be watered down to avoid embarrassment and to satisfy ethical consideration, which would make it unsatisfying for the specialist. Scrambled-image transmission deserves close examination. A survey in the United States in 1959 revealed that 20 medical schools had some kind of television facility for undergraduate and postgraduate programs. Many local commercial television stations were broadcasting to practitioners. This help could create convenient lecture conditions and stimulate wider interest.

Dental surgeons have taught intraoral manipulations to students, using television. Orthicon cameras have been used extensively to televise surgery. Although color is better for surgery, black-and-white television compares favorably with former restricted viewing methods, and color still needs further development, a big staff, tremendous increase in illumination, and a large budget. Electronic devices, such as the electroencephalograph, electrocardiograph, and electromanometer, are space-occupying, tend to impede free movement, compromise asepsis, and add to the risk of explosion. Now, most equipment can be mounted in an adjoining room, and data from monitoring dials can be transmitted by television to a single screen immediately available to the surgeon. Television surveillance is now used with patients treated with high-voltage radiotherapeutic equipment, and with an intercommunication system it is also possible to boost the patient's morale. Closed-circuit TV allows continuous watching of patients in mental hospitals.

Permanent records can be made by recording from a special screen with a synchronized movie camera. The film can be stored and displayed either as a single frame or as a movie sequence. The record is not immediately available, however, and storage occupies much space. Videotape can be wiped and re-used. This equipment is exceedingly expensive, and it is not possible to view a single still image. An after-glowing screen holds the picture for a certain time, but the first picture has to fade before a second can be scrutinized. The memory tube holds the picture for a certain time but the picture can be displayed only on the tube itself. The magnetic wheel is a rotating drum with an endless magnetic tape that records the image of one complete television field. After recording, automatic display is possible, and the image can be stored indefinitely. Storage of the electronic signal in a special charge-storage tube is possible, and allows immediate display of the picture. There is storage of complete contrast that diminishes only slightly after 10 minutes of continuous display. Several pictures can be stored at the same time. It has stroboscopic viewing, which allows one to follow slow movement, and it allows substantial reduction of X-ray dosage. This method does not allow display of fast movements, such as those encountered in angiocardiography, and the tube has a guaranteed life of 600 hours only. The X-ray image storage, however, affords the best conditions at the present time.

10.2 British Medical Journal, "Television in Medical Education." February 1961.

Medical uses for television should be examined in Britain. There is great potential for surgery and for shortening the teaching curriculum and making it more effective. In endoscopy, good views of the interior of the ear, nose, larynx, and bronchus can be obtained, and the viewers see on the screen what the endoscopist sees with his instrument. Lighting equipment, periscope, and TV camera are now available for use in teaching laryngology. The radiologist now can use remote control, image intensifier, cine-unit, and television camera to study disordered physiology. In psychiatry, the 2-person interview can be studied via television by students, without changing the interview's dynamics. The student can see facial expressions, gestures, interviewing techniques, and progress of treatment. Ethically, the patient must be told about the purpose of the camera, and must give his permission for its use. The "sentinel" camera also can be used to observe the critically ill, the suicidal, and the confused, especially if there is a nurse shortage.

The medical student is more impressed by seeing live body processes than by lectures or diagrams. The general practitioner could watch weekly lecture-demonstrations conveniently designed for his postgraduate education. In the United States, the Council on Medical Television was founded to coordinate television efforts of schools and institutions in this field. Its 1959 report should be studied with the idea of setting up a similar organization in Britain.

10.3 Brown, M.C. "Television and Medical Education," World Medical Journal, March 1962.

The "electronic image processor" perceives and converts information presented in the form of a picture into an electronic signal, which is processed to present the information meaningfully. This type of instrument is assuming importance in medical research, education, and care of patients, but its exploitation is only beginning. The instruments are of two general classes: one employing scanning, whereby television pictures are made; the other resembling the X-ray image intensifier tube, transmitting a whole picture at one time. The two classes are frequently combined. These instruments all amplify light and size, enhance contrast, and are unobtrusive, noiseless, and capable of remote operation and concealment. Information can be transmitted any distance and stored for future use. Some of these instruments can see in the dark with infrared or ultraviolet light.

Information can be made available by pictures, oscillograph traces, counts of objects or movements, and computer data (analog or digital). As a picture, the full image can be modified to yield line drawing, to sharpen fine or gross detail, interpret gray scale as shades of color, obliterate unwanted information, and simultaneously, bring out fine differences in density. Color introduces a host of new possibilities.

Most frequently used educationally is size amplification, where a closeup magnification of some procedure is presented to students on a monitor or screen. The professor and students in the same room see every detail demonstrable. This process is also useful in clinical demonstrations.

The unobtrusiveness of electronic image processing has made it almost essential in teaching psychiatry. The intimate interplay between psychiatrist and patient need not be disturbed when television makes the experience vicariously available to students. The television technique can be applied to other situations where the presence of students would affect the teaching situation. The patient's right to privacy is met by informing him about the television procedure and obtaining his consent. Patients usually forget about the presence of the camera after the first few minutes.

The classic example of electronic image processing as an amplifier of light is in radiology. Fluoroscopy in teaching-hospitals now mostly uses machines equipped with image intensifiers and a television pickup system, providing reduction in radiation to the patient and considerable gain in diagnostic interpretation. The radiologist saves time by not having to dark-adapt, which also allows flexibility in scheduling procedures. The teacher of radiology can demonstrate to larger groups not present in the fluoroscopic room, for longer periods, and without hazard to patients. Unusual material can be taped. Thus, one radiologist could supervise graduate students in several different hospitals. Some radiologists are using contrast amplification to interpret difficult diagnostic problems. It is likely that these devices will, over the next few years, provide improved clinical and teaching advantages.

The author and his colleagues have used conventional television equipment to observe behavior, record professional meetings without special lights, record teaching materials, enhance microscopic contrast, permit group viewing of a wide range of phenomena, enlarge or reach audiences for teaching sessions, present detailed clinical findings, and present living physiology without disturbing the tissue under observation. The possibilities nevertheless have been explored only superficially.

Their cardiac catherization laboratory (which uses an X-ray image intensifier) is also concerned with measurements of various cardiac activities. Almost all data collected result in a visual presentation, providing opportunity to use electronic image processing very effectively. The students can follow the cardiac outline and excursion of its borders on a monitor as the events are discussed by a competent teacher. Cardiac and large-vessel physiology can be taught dramatically, directly from a living human subject.

10.4 Cameron, C.S. "Five Schools Linked Together for TV Teaching," Journal of Medical Education, Vol. 34, No. 11, November 1959.

Philadelphia's five medical schools recently presented a joint closed-circuit color television series on forensic pathology to some 1,000 juniors and seniors. Students remained in their own lecture halls without disruption. Special techniques and cameras gave close-ups of materials usually difficult to see in lecture demonstrations. Dr. Joseph Spelman, Medical Examiner for the City of Philadelphia, who lectures on this topic in medical schools when possible, cannot fulfill all requests for teaching. With these five lectures he reached all five schools simultaneously. The hour-long lectures were scheduled at 5:30 p.m., which eliminated the dinner hour for most students, but attendance, which was voluntary, was about 80 percent. No regular class time was sacrificed for the series.

Lectures originated in the laboratory-studio of a major pharmaceutical firm, under the aegis of its experienced color-television staff. Video was transmitted by microwave relay and projected on 4 x 6-foot screens in each auditorium. A "party-line" telephone hookup carried amplified audio while providing a direct line for student questions (through a moderator at each school), which Dr. Spelman answered directly from the screen. It was later felt that the moderators' voices should have been audible in order to add impact. Despite the presence of mechanical gear, the 2-way sound connection preserves much of the intimacy of a primarily conversational exchange of ideas between teacher and student. The effect is further enhanced by a first-rate color television.

An experimental camera was mounted on a microscope to show fine detail in sections. Blownup images of illustrative slides were almost as clear as direct viewing. The lecturer also used gross specimens, projected color transparencies, implements causing death, charts, graphs, and other devices. Ordinarily, the assembling and transporting of such materials are onerous chores, and teachers often settle for the easier textbook or straight lecture. The improved teacher-student ratio effected by television encourages the use of demonstration materials. The visual approach dominated, and the teaching impact probably doubled. Because the room had to be darkened for optimum clarity, mimeographed or printed digests are suggested for future projects.

The viewers' impression that the performance was smooth resulted from a judicious choice of lectures coupled with the skill of an expert production team. Students, teachers, and deans were pleased and enthusiastic, and several deans felt there were other fields in which this type of program would serve equally well. There were some stray negative comments from students who were repelled by the sensationalistic material. Dr. Warner Sheldon, of the University of Pennsylvania Medical School, commented that the public expects doctors to know about these things, and that real education, not the tabloids, should be the source of reliable information.

This successful experience suggests an answer to the critical teacher shortage. We should exploit the talents of the rare "master teacher," sharing top-ranking men via television quickly and easily, with minimum administrative disturbance. Color television allows the teacher to make more versatile, clearer, and more accessible presentations to large numbers of students without radically altering his basic methods. It cuts through the impasse of close observation for large groups at the point and time of occurrence. For example, placing the television camera a few feet above the operating table, and using magnifying lenses brings the audience a view equal to the surgeon's and better than that of most members of the operating team. With new progress in electronic engineering there is corresponding new opportunity in teaching.

10.5 Dryer, B.V. "Medical School TV Teaching -- Three Case Histories," Paper presented at the meeting of the Council on Medical Television, April 1960.

Western Reserve University School of Medicine has organized the preclinical sciences and clinical training and categories of knowledge -- anatomy, physiology, biochemistry, pathology -- under the control of interdepartmental committees. Much curriculum content is organized by body systems -- the nervous system, cardiovascular, etc. The students are introduced to the study of patients early in their freshman year.

Careful survey indicated that students were unsure of their roles and relationships with patients. In teaching knowledge, skills, and attitudes, the school has traditionally tended to give very little help to medical students in dealing with the doctor-patient relationship. Now, for freshmen it has established a brief television interview with a selected obstetrical patient. The faculty thinks that there is an advantage to uniform exposure of all students to the same event, allowing for group discussion and interpretation; reality of seeing doctor and patient talking quietly in an office setting; immediacy of showing the event happening; and discussion of principles by a second, classroom teacher during presentation.

Teachers often bring preconceived ideas to educational television, derived from commercial television. They are relieved to learn they will not be overshadowed by its use. Lecturers appear in person, as well as in a "glass box," and regular lectures and seminars are conducted as always, except that a television demonstration, which can be controlled or shut off, illustrates the material. There is no stopwatch, script or rehearsal, only agreement on sequence of events.

The equipment at Western Reserve consists of a vidicon camera mounted on a standard tripod. Ordinary room lighting is usually used. Five places in the building constitute input points. Direct cables in the walls connect to the auditorium and there is intercommunication to the cameraman. The wall cables cost about $2,000 because they were planned in the blueprint in order to avoid the nuisance of mobile setups, which inconvenience both patients and staff. The camera, equipment, and receiving set form a basic unit which costs about $3,000. Oversized wheels were mounted on an ordinary industrial cart to help wheel supplies over the slight difference of level when entering elevators.

The teaching target of one case history was to correlate clinical and basic science aspects of coronary artery disease, for 2d-year students. The teacher in the auditorium was a pathologist describing gross and microscopic features of coronary disease, with slides. As he shifted from structure to function, the students turned on the television set to see and hear an internist taking a history from a patient with coronary artery disease. The pathologist in the auditorium was free to comment and answer student questions. After about 15 minutes, the pathologist turned off the set and continued his lecture. The internist then entered the room and the class switched to the seminar method. The immediate juxtaposition of structure and function aids in the learning process by association of the living proof of the patient and subsequent anxiety in his life, a juxtaposition which emphasizes the "comprehensive" approach. For this 2d-year class, teaching a skill, in this case history-taking, was touched on lightly.

Another case history illustrates teaching the reproductive system to 3d-year students. Television, instead of direct delivery room observation, is used to show a woman in the final stages of labor, relating this knowledge for a truly scientific practice of medicine. The aim also is to introduce the theme that there is a great deal we do not know and a subsequent need for research. Therefore, two receivers are in the classroom and two cameras in the delivery room. One camera and one receiver are devoted to clinical science, and the other units to basic science. The first receiver shows a woman in labor; the other a variety of equipment for data collection -- oscilloscope, infusion pump, manometers, electrocardiographs, etc. It is the job of the classroom teacher to correlate the information on the two receivers. For effectiveness of teaching technique, only one part of the material is presented at a time. This presentation requires much tighter structuring and preplanning than the one previously described, in order to serve best the classroom teacher, attending obstetrician, and the patient herself.

This presentation occurred in a hospital without built-in cables; consequently, the lines had to be run through hospital corridors and doorways. The setup had to be worked out carefully in advance with nurses and electricians. The experience emphasizes the importance of new medical school and teaching-hospital construction which anticipates the use of closed-circuit television.

On the basis of experience, Western Reserve is willing to proceed on the hypothesis that closed-circuit television has a valuable contribution to make to medical school curricula. It can help to build a bridge between 4 years of student learning and 40 years thereafter of physician living.

10.6 Engel, C.E., and Warwick, R. "Colour Television in University Teaching," Nature, Vol. 181, January 1958.

Fourteen departments of Guy's Hospital Medical School and others co-produced an experimental series of 16 television demonstrations in London one evening to judge the medical teaching potential of color television. Meticulous planning was required to shift the two cameras from one demonstration to another in less than 2 minutes, but the precision was remarkable. Few of the busy doctors and lecturers were able to rehearse more than once or twice, an important point because it might have been assumed that television would exact undue demands on the lecturer's time. The consensus was that quality and color were well above reasonable expectations, pointing up the need to investigate thoroughly the possibilities of this medium in medical teaching. Such a test would of course have to be conducted with considerable reduction in the complexity that attended the present demonstration.

With color television, events and phenomena, some of which may not even be directly visible, can be observed at a distance on large projection screens or smaller monitors in any desired number of places by large audiences at the exact time of occurrence. A range from fine detail to large scenes can be shown. High-power microscopic examinations can be made with considerably higher brilliance than with conventional projection microscopes. Experimental endoscopes can keep pace as associated optical problems are solved. Live presentation, film, slides, and charts can be shown in any sequence or side by side, allowing correlation of separate aspects of the same subject or contrast of similar phenomena.

The psychological effect alone upon a student of seeing live action the moment it happens may prove considerable. A film is rigid in presentation and cannot easily be stopped, whereas with television a lecturer can control his presentation, thus importing a personal sense of immediacy and liveliness often absent from films. It is easy to answer those who favor films by pointing out that even if funds could be raised to establish and maintain sufficient film production units for all of the many subjects necessary, few teachers would have the time required for drafting the initial treatment, supervising scripting, conducting rehearsals, and shooting and editing such films. Even if all these films could be made, they would not fit in with each teacher's ideas or be equally effective for different types of audiences. Some quickly become dated, and there are inevitable delays between preparation and exhibition. Such handicaps do not apply to television, where the lecturer can discuss his needs with his assistant, place the camera in position, and direct the proceedings while talking to his students.

No one imagines that color television will solve all teaching problems, nor would any responsible teacher allow an elaborate electronic device to come between him and his students when a normal direct approach is more appropriate. But experience shows that television may permit valuable content additions in teaching medicine, especially in the realm of bringing to large audiences things rarely possible to show even to a select handful of students. Experiments covering the full range of possible applications in the teaching medical center may therefore have far-ranging effects on education -- and even perhaps on the public.

10.7 Hospital Handbook, "Survey Report of Evaluations by Hospital Administrators on the Various Applications of Closed-Circuit Television in Hospitals." 1956.

This handbook details the applications of closed-circuit television for increased efficiency of hospital functions and procedures. Hospital administrators discussed and evaluated survey forms for this study and clearly indicated serious contemplation of television to improve patient care and to reduce operating expenses. An average of eight applications were given the highest rating (A) in evaluating closed-circuit television; six other uses were rated with a value second to the eight preferred applications (B); and four applications were rated as having low value (C). Six applications of closed-circuit television were rated inapplicable.

The following applications were listed in order of importance: surveillance of seriously ill patients; pediatric ward surveillance; televising emergency messages; nursery surveillance; X-ray intensifier; visiting isolated patients; televising religious services; general ward surveillance; training interns and residents; corridor surveillance; nurse and attendant training; remote viewing in doctors' rooms of autopsies and surgical operations; televising special entertainment and motion pictures for patients; visiting obstetrical patients; therapeutic X-ray and radioisotope laboratory control; volunteer nurse's aid training; observing patients for diagnostic purposes; televising menus; televising patient instruction and education; microscopic image transmission; X-ray film transmission within hospital; fund raising.

Patients viewing TV programs from local stations were listed last, but this actually is not a true closed-circuit function (although permanent monitors installed in the walls of patients' rooms allow this viewing).

10.8 Huber, J.F. "The Need for a Medical Communication Expert in a Medical Center," Journal of the Biological Photographic Association, November 1961.

The communications expert should act as director, administrator, or coordinator in charge of such audiovisual assistants as photographers (still and motion picture), medical illustrators, television specialists, audio specialists (radio, recorders, public address systems), equipment service, and duplicating technique specialists. He would be the person to advise medical teachers, most of whom have had no special training in educational disciplines or presentations, on which communication device or technique would best put across all or part of a presentation. He could then expedite his advice by calling in his appropriate staff specialist. He could assist teachers by establishing an intramural library of communications materials (films, filmstrips, slides, models, recordings) and also by simply having an awareness of materials available from outside sources. He could assist in the design, research, and effectiveness of various teaching presentations. Medical researchers would benefit if someone could help to report and make public their findings appropriately, through such channels as journals, films, papers presented at scientific meetings, etc., and at the same time supply them with material for technical observation such as audio or visual equipment. He could be of public-relations assistance by aiding in the production of informational materials (booklets, charts, photographs, posters, exhibits, etc.) and of administrative assistance by helping in the preparation of reports, statistical summaries, budget substantiation, support requests, and fund-raising.

10.9 Leveridge, L.L. Preliminary report of Intramural Television at New York University Medical Center (Experimental Uses of Closed Circuit Systems). New York, March 1961. (mimeo).

The pathology laboratory class is divided into four sections, and further subdivided into two when organs are being demonstrated. After 8 demonstrations, fresh organs are often damaged beyond recognition. Television offered a saving in teacher time and made 8-fold repetition unnecessary. Fresh organs were handled less and remained in better condition, and everyone in the class had an equally good, highly magnified view. Two monochrome cameras with 600-line resolution were mounted high over the demonstrator's shoulder and were controlled by foot switches. Two receivers were placed in each classroom. One-way audio communication permitted student questions to the demonstrator via the classroom instructor. Disadvantages were lack of color, some difficulty in recognizing demonstration objects, and lack of direct contact between student and teacher. The instructor felt that extra time was consumed because demonstrations were repeated in person for some students. The student audience was gradually enlarged when anatomical structures and lesions were seen well on the screen. Television was not integrated into regular teaching time, but used in periods when students were studying for examinations. Many students felt this to be an intrusion. The original intention -- to circulate organs after the demonstration -- was not carried out because answering questions took more time than the demonstration. Most students lacked enthusiasm for this use of television and teachers were predominantly dissatisfied with it.

For studying microscopic fixed and stained histological sections, the microprojector is unsatisfactory because it lacks brightness for high magnifications. Television provides a brighter, better-quality image. A monochrome camera providing 700-line resolution was employed with a 14-inch monitor for the teacher and two 24-inch receivers, placed in one of the classrooms. One-way audio provided for the teacher to be heard by the class. One teacher simultaneously instructing four laboratory sessions saved teacher time. Disadvantages were the lack of color, resolution inferior to direct viewing through the microscope, and low-power view not equal to a good microprojector. The equipment required adjustment for maximum contrast whenever microscope objectives were changed. There was lack of direct contact between student and teacher. All sections had studied this material beforehand, and television teaching was not part of the regular instruction. The teaching method was not essentially modified to fit the use of television. Students found the presentation useful, but some had negative reactions. Those students who were not notified of the television presentation, however, resented the exclusion. Teachers felt that automatic electronic compensation for microscope changes would be needed to make this method useful. Actually, the 600-line resolution camera is automatic, and if used differently, might prove adequate. It is also possible that another visual medium, such as color transparencies, can serve as well or better.

It is difficult to make accurate measurements with the small image seen directly through an eyepiece when microcirculation in perfused, excised living tissue is observed responding to various pharmacologic agents. Only one person can observe the action. Television image magnification resulted in greater accuracy of measurement, less fatigue for the technician, and immediate results -- in contrast to photography. A beam-splitter was used, incorporating a micrometer scale interposed between water immersion microscope objective and a 700-line resolution camera mounted over the microscope. Disadvantages were the cost, bulk of equipment, and required adjustments of equipment. Because it took longer to make measurements, the equipment will not be employed for this purpose. However, the equipment was so useful for demonstrating to frequent laboratory visitors that it may be purchased for this purpose.

A 5-inch, image-intensifier fluoroscope is used for cardiac catheterization preceding cine-angiocardiography. The present observation is made through a mirror; a precise head position is required for the manipulator, and there can be no observers. The simplest method of overcoming this problem is to remove the 35mm camera and replace it with a 700-line resolution television camera. The image appears equivalent to that seen on the viewing mirror. Lacking a mount for the camera, N.Y.U. could not proceed with an actual cardiac catheterization, but steps are being taken to procure a mount.

A demonstration was held of cannulation of the saphenous vein and neck dissection, which, if demonstrated directly, would allow few students to see the tiny structures involved. Television magnified these small structures. One monochrome semiautomatic, 600-line resolution camera was positioned above the demonstrator's shoulder. The teacher rehearsed the entire procedure beforehand with a cat, while other members of the physiology department made suggestions. The television demonstration first showed the procedure to students before they undertook it themselves. Disadvantages were the lack of color (although this did not seem a great handicap and was a small price to pay for greater image sharpness and greater contrast) and a sometimes unrealistic expectation of size (one student expected to find a much larger carotid artery). The students were, however, uniformly enthusiastic about being able to see a laboratory demonstration clearly. Time was saved, and students were free to spend more time learning physiology instead of struggling with the surgery needed.

10.10 Mackenzie, J.K. "The Medical Television Director: His Relation to the Medical Educator," September 1957. (Multilith)

Contrary to some opinion, the author believes that program direction for medical television should be by laymen, not physicians. During preliminary production meetings, the questions he asks the doctor about presentation cause the doctor to rethink and frequently to revise his approach; the revision would not have occurred had the doctor and director been on the same plane of professional communication. The director's advice is eagerly sought and usually accepted unquestioningly. If the director were also a physician, neither would have the pleasure and satisfaction of exchanging knowledge. For the novitiate television educator, this opportunity is often a needed therapeutic distraction, affording relief from anxiety of initial contact with television. The doctor-director might also find it difficult to decide where his allegiance lies -- with medicine or television. Finally, the doctor-director tends to interject personal considerations and opinions arising from medical training. Occasionally, doctors have misinterpreted television advice to be an attempt to give medical advice, which is understandable because television limitations and requirements frequently necessitate drastic revision or even elimination of part of the doctor's presentation.

Physicians frequently experience doubt, suspicion, and fear, and in rare cases, they actually express open hostility in the television situation. An understanding director can alleviate these feelings. In clinical presentation, where present conditions are changed greatly from those the doctor is used to, these feelings are most likely to occur. The director must judge whether to take time to lead the physician to realizing his error or tell him openly. The author, a lay director, sometimes uses "program invention" to present an idea he wishes a doctor to incorporate into his presentation: the author "remembers" a similar way it was done before. An idea already accepted and used by another member of the profession becomes far more acceptable to the physician than if it had been the author's.

The lay director has a responsibility to the physician and his reputation, which has been gained at great effort and which is integrated with vital intra-professional recognition. The short scrutiny he will receive on television from his colleagues, most of whom have never met him, is much more piercing than appearances in print or in lecture halls, and will have a bearing on subsequent professional references to the physician. The director must also remember that closed circuit television is a communication medium existing under shortages of competent educators and a growing tendency toward urban centralization of teaching facilities and materials.

The educational purist who rejects presentation advice because he is "here to teach, not play around with acting" is best reached by the director's exchanging places and duplicating the doctor's delivery while the doctor watches on a monitor. The director must be careful not to overuse visual implementation and to use his own judgment. Ten consecutive charts are best relieved by switching camera focus intermittently.

A future postgraduate course for laymen interested in closed-circuit, medical color-television will benefit the medium. An institution willing to spend the money required for color installations will want competent personnel for maximum efficiency. Several universities have already had sad experiences with unqualified personnel. There is also an unfortunate tendency for administrators to think that equipment need only be manned by a group of clinicians. If medical education can acquire capable laymen as photographers and technicians, this same thinking can soon be applied to medical television. Already, a small number of physicians have given up practice to supervise graphic arts departments or medical television departments specifically. With further progress, young doctors may turn to medical television specialization. This does not contradict the author's feelings about the doctor-director -- with progress, medical educators will not be completely dependent on the director for basic television instruction.

10.11 Mackenzie, J.K. "Closed-Circuit Television for Medical Education: Factors Affecting the Audience," September 1959. (Multilith)

Television presentations, unlike lectures, do not present peripheral distraction to the eye, but rather impose a high degree of visual concentration because of contrast between bright screen and low room illumination and because of the camera's ability to isolate and present selected objects or people. Because the televised lecturer addresses the camera, the illusion is given that he is personally addressing the viewer, in contrast to his continually shifting line of gaze in a lecture hall. The public, both professional and lay, has become accustomed to a high standard of commercial television presentation. Even the guest lecturer with no experience receives intensive professional preparation behind the scenes to insure smooth delivery on commercial television. The time is near when doctors will be asked to pay for televised postgraduate education, and they will expect the same perfection of presentation. Novelty is a factor in acceptance or rejection of a new medium. The present generation of children accepts television as something that has "always been around," and unlike their elders, will have little difficulty when they are ready to participate in medical education via television because of little awareness of innovation or of its inhibiting by-products of controversy and resistance to change. Because the public relates entertainment to television, doctors are provided the opportunity to use novel methods to illustrate their lectures. The fact that teacher and student are separated allows the audience a sense of freedom. In programs sponsored by pharmaceutical houses, questions are asked by physicians in the audience that reveal basic lack of knowledge, and that would probably never be asked under standard lecture hall conditions, but that may express a genuine desire to learn the specialist's area. Other signs of freedom are inherent in frequent and boisterous laughter, marked excitement and intensity over some highly controversial procedure or debate, frequent arrivals and departures, and inter-audience exchanges. In the case of undergraduate, graduate, or subscription programs the circumstances might be altered.

10.12 Mackenzie, J.K. "Medical Television References," New York, July 1958. (Mimeograph)

This bibliography is designed to aid medical and paramedical personnel seeking further information on various applications of TV to medical education and research. This is a preliminary study in the sense that additional material will be covered and further studies made, and the author, who has not read all the material, does not attest to its quality or accuracy. Preliminary investigation of reference sources seemed to indicate that the following categories were covered frequently enough to require individual headings: Audiovisual (departments of -- illustration for); Dentistry; Education (closed- and open-circuit); Endoscopy; Microscopy (cytology); Nursing; Obstetrics and Gynecology; Ophthalmology (optometry); Physiology; Psychiatry (psychology); Radiology; Surgery; and miscellaneous and unpublished material.

10.13 Markee, J.E., Agnello, S.A., and McFalls, F.D. "Closed-Circuit Television at Duke University Medical Center," 1962. (Multilith)

In terms of versatility, the TV system at Duke University Medical Center rates as one of the top four centers. This closed-circuit system was installed as a single-channel system, with the first teaching presentation in 1960. Since then, 152 presentations have been televised for 181 hours of air time, with 25 different instructor-demonstrators, and students including 1st- and 2d-year medical, nursing, physical-therapy, and graduate students. Subject areas include anatomy, physiology, pathology, and radiology. In 1961, work was begun to expand to a 4-channel operation, to enlarge scope of transmission, and to make possible inclusion of more locations to the system. The present system represents a monetary value of $184,500 derived from eight sources.

In addition to basic teaching, television is part of training for graduate students and house officers spending part of their time in the anatomy department. Participation from this country and Canada in a pathology teaching conference in 1961 revealed many of TV's possibilities. In 1961-62, "disaster rehearsals" were held at Duke University Medical Center. Television was used as a means of communicating information to Disaster Control. A television camera counted "patients" entering, vehicles waiting to be unloaded, and the number of real patients arriving. Plans are being made for television aid in the event of real disaster.

"In-class" demonstrations have the teacher and students in the same room with television cameras and monitors, and "remote" presentations allow the teacher to present all or part of the material from another part of the building. In each case, a teacher is stationed with students, and a direct relationship is maintained. The audio system has two separate parts: that which the students hear, originated by the teacher-demonstrator; and a second part for intercommunication among four team members. The cameras and monitors are mobile, but all cables are situated in the building structure with the proper receptacles at each of the origination and reception sites. The control room serves as the nerve center for all cabling, and also has a multiscanner that enables the Medical Center to originate opaque photographs, lantern slides, drawings, and movies, which can be integrated with other video signals by use of a switcher-fader device. Duke has always insisted on broadcast-standard equipment, even though at present they are a closed-circuit system. They anticipate incorporating their present system into an open broadcast unit. Their extensive cables allow students the use of a vast array of teaching material from almost any location in the medical center, and in turn, transmission of basic science demonstrations to clinical areas. They can reach any room in the center.

Duke has recently acquired recording equipment, broadcast videotape, and kinescope, and vistas for teaching and research are beginning to develop. The cardiac catheterization laboratories will be using this equipment regularly for patient care and teaching. Unusual teaching and clinical material can be recorded permanently, therapy of chronic illness can be compressed in time, and visiting speakers and medical symposia can be recorded. The Medical Center has tested anatomical knowledge via television. The videotape recorder will be used for recording "core material" for teaching, recording experimental data, patient examinations and interviews, and videotapes will be exchanged with other medical centers.

10.14 Markee, J.E., Agnello, S.A., and McFalls, F.D. "The Use of Television for Teaching at the Duke University Medical Center." Unpublished address, 1961.

Of 1,250 students, about 1,000 are in residence at the Medical Center and about 250 return for continuation education. Television for teaching and patient services is increasing at a rapid rate. The Center began television-teaching on a small scale, but plans and installation of equipment are compatible with continuous expansion. Television has been used most extensively for anatomical instruction -- supplementary to laboratory work, elective viewings of motion pictures, and audiovisual presentations. Additional use of TV in anatomy in 1st- and 2d-year instruction will involve surface anatomy, prosections, muscle testing, radiology, and patient demonstrations.

The Duke installation basically involves a central control room with fixed equipment connected by video and audio cable to seven rooms, and mobile camera and monitors. In addition to permanent wiring, Duke has a 100-foot extension camera cable that multiplies origination and reception sites. In most TV classrooms, students are with a senior teacher away from camera, cameraman, demonstrator, and control room. The students hear the teacher-demonstrator or senior teacher on one part of the audio system, and four members of the team use their own intercommunication for coordination during presentations without distracting the students. Television is sometimes combined with color slides and motion pictures to project interrelationships of an anatomical entity on a conventional screen. In the control room is the switcher-fader-mixer that aids in achieving continuing integration of the isolated example with the general principle.

Occasionally, demonstrations have been televised in the same room with the students. Although the student has maximal contact with the immediate situation while viewing an enlarged image, he is nevertheless viewing only a single example or series of examples, and important generalizations can best be supplied by artwork or other visual aids originating from the control room. If the camera is not in the room with students, lighting presents fewer problems than encountered with motion picture photography, but even in the classroom it can be controlled so that it will not distract students. In the "in-class" situation normal room light has been utilized, plus a spot or small flood to highlight the subject matter.

The Duke installations have cost between $10,000 and $20,000 so far. An average of 14 man-hours per presentation, or a total of $33 representing salaries for the six people directly concerned has been spent. The money was already budgeted, and would have been spent for teaching in some other manner, but this sum does not include capital outlay for equipment, supplies, and materials. The primary objective has been to achieve good teaching, and to this end the minimum group involves at least four people, with the demonstrator the one most competent in the presented subject area. Much of the Center's success in using television for anatomical teaching is related to the fact that four different competent young staff members have served as teacher-demonstrators.

10.15 Matthias, R.C. "The Production and Use of Televisual Aids for Medical Education," Biological Photographic Association Journal, Vol. 29, No. 2, May 1961.

Medical photographers and illustrators are part of an integrated team for communicating ideas, and are responsible for the creation of motion pictures, slides, artwork, and other televisuals. Certain limitations necessitate special preparations. In photography, the resolving power is limited by the lens and emulsion, and although a satisfactory picture is obtained by the low-resolution television chain, it relies on, and is enhanced by, closeups. Electronic cropping loses part of the picture, and distortions due to geometric scanning further hinder quality. The factors that cause eye strain -- electronic soft focus, exaggerated contrast, and small screen size -- are the same factors that tend to confuse details.

Graphic art presentations depend on the area the camera will frame. Still material must conform to a 4:3 ratio of width to height. For opaque reflection copy, an 11 x 14-inch card is ideal to establish a workable camera field of 6 by 8 inches, with margin for error. To keep within these boundaries, a simple overlay can be photographed. If a vertical arrangement is necessary, it should be prepared for panning by extending the top and bottom borders so that each are 25 percent of the height of the panned camera field.

Most televisuals are prepared on heavy stock with a matte surface, and should be neutral in color, never white or yellow. Simply organized material is most understandable and instructive. Radical abbreviations are helpful. Titles and headings are best eliminated. Sans-serif lettering is most effective. Templates and pens or die-cut letters of paper or cardboard available ready-gummed in black-and-white or colors are efficient for short cuts. Other lettering aids include pressure-sensitive and transfer lettering. Graph lines must be bold, rarely less than 1/32-inch thickness. Available aids for statistical data include tapes for curved lines and solid bars, and color overlay sheets.

Distortion of the gray areas can be minimized by use of only four grays plus black-and-white for faithful electronic reproduction. Black-and-white should be composed of grays that do not contrast harshly, but the range should not be too limited, and large black or white areas should be avoided. Color work should also be visualized in terms of grays because the gray scale determines colors for television. A palette system makes it possible to predict the gray equivalent of any color for black-and-white or color television.

Sometimes realism in medical art has to be relinquished for television. Cartoons (caricatures that employ simplification of line and detail) often can be more effective than attempts to be realistic. Drawings of surgical procedures should be simple, black-brush outlines with color to accent vessels and nerves. Pathological conditions may be preferable in color, with a free and sketchy combination of tone and line. Aids include mechanical paste-ups of colored-paper cutouts, particularly valuable for duplicates; spray paints for interesting textures; and matter shading films, to give the effect of transparent organs. Diagnostic details can be shown by composites of photographs and drawings.

A card may be integrated into the live action by static display on an easel and changed in front of a single camera, or may be involved in some kind of movement that grows or animates on the screen. For example, a picture can be put together simply and inexpensively by adding elements to a flannel board; movement can be gained by rigging up cutouts; a graph line may be moved by sliding a panel of some contrasting shade behind the card out of which a line has been cut. The only limitation seems to be imagination and ingenuity.

In still photography, prints should have a low maximum density in the shadows, and be in sharp focus without contrast for televising. For limiting the essential picture to the 6 by 8-inch area previously mentioned, a few minutes spent drawing an enlarging-easel guide outlining the scanned area will save many long darkroom hours. Matte surface avoids glare. To minimize a lingering image tendency, prints should be tinted in a solution of blue or green color. Photographs must be mounted to withstand heavy use. Rubber cement applied with the pressure of a print roller is effective. Dry-mounting is probably best done with a hot press, sandwiching a sheet of wax-impregnated paper between print and background material. With slides, essential picture information can be kept within the proper boundaries by diagrams copied and printed to the correct size on film, trimmed and laid over the ground glass of the camera. Print production techniques apply to slide-making and motion picture-making, with a few basic departures. Composition of the image must comply with the standards of the Society of Motion Picture and Television Engineers. In addition, it is preferable to use more closeups, and compose shots much tighter for television. Lighting must be kept at a low contrast ratio, preferably 1:2, but never exceeding 1:4.

Standard slide projectors are in general use, but if necessary, an inexpensive projection system can be fabricated by mounting a 35mm projector and a 3¼ x 4-inch projector side-by-side on a stand 36 inches from a 9 x 12-inch rear-projection screen. The image must be projected backwards. It is then picked up from the screen by a studio camera with excellent results. Although most stations have specially designed equipment for showing 16mm films, a system for 16mm also can be improvised. The projector should be fitted with a TV shutter so it will scan 30 frames per second instead of 24. Studio lighting should not fall on the screen; framing it with a shadowbox helps. To retain proper sound-tracking, the image should be reversed with a prism, rather than by film reversing. An effective pointing device is a darning needle, which should be used on the projector side of the rear-projection screen so it will cast a dark shadow.

New and interesting visual aids should be devised to add to the primarily visual medium of television. When X-rays are used for case histories, original film should be used when possible. The film should be transilluminated on a standard view-box for pickup by the studio camera. Effective visual aids include patients demonstrating a disease or treatment technique, small manikins with movable joints, and 3-dimensional models to demonstrate anatomical relationships. Any type of equipment, instrument, or machine aids detailed descriptions. A commercial product is available to dull reflections on shiny materials, which cause blind spots. For televising actual surgery, light green or blue drapes should be employed around the surgical site. Highly reflective instruments can be dulled with sterile bone wax.

10.16 Remley, F.M., Jr., and Judge, R.D. "Technical Considerations in Closed-Circuit Television," University of Michigan Medical Bulletin, Vol. 27, No. 6, November-December 1961.

The University of Michigan Television Unit selected standard broadcasting equipment -- "compatible color" for use. The only limitations lie in the design of present-day viewing equipment. Signals can be sent over standard television stations or closed-circuit systems, and may be viewed on ordinary home television receivers in color or black-and-white. Their equipment includes a mobile studio and orthicon color camera of high light-sensitivity, vidicon color camera of relatively low light-sensitivity mounted permanently in an operating room, another vidicon color camera permanently mounted to reproduce color slides and motion picture film, and a portable monochrome (black-and-white) vidicon used throughout the Medical Center or studio to augment the color camera. A complete sound distribution system facility with necessary testing and auxiliary amplifying equipment was installed. For viewing, a large-screen projector and 13 color receivers were procured.

Most demonstrations originate in the University's hospital television studio, which is approximately 20 by 20 feet, is equipped with 20 standard television studio lighting fixtures, and has an adjoining control room housing equipment for monitoring and amplifying signals from the cameras. The surgical camera is operated remotely here. Both rooms are completely air-conditioned because of the heat generated by the racks of equipment and lighting fixtures. Conduits carry video and audio cable throughout the Medical Center. The Medical School draws upon the experience and skill of seven full-time television engineers from the University Television Center, who operate and maintain the television, lighting, and sound equipment.

Future plans include transmission to adjacent University buildings and hospitals in a 3-county area of southeastern Michigan, thus eliminating much traveling for teachers and also facilitating postgraduate studies. Also planned is greater utilization of a color television tape recorder now in the University's possession. Color tape, a major advance, is easily edited, may be used repeatedly, and costs only a fraction as much as color movie films. A newly developed optical system that couples the television camera to a microscope may soon be available to these units, thus making possible convenient demonstrations of pathological material directly from slides. This would be superior to even the best projection equipment and would provide accurate demonstrations of high-power and oil-immersion fields simultaneously to a relatively large group of students.

10.17 Ruhe, D. "Television: Monster Growing Larger," Journal of Medical Education, Vol. 28, No. 1, January 1953.

Television will soon serve all medical students, practitioners of all specialties at their hospitals or directly in their offices, and the lay public in respect to the medical sciences. In 5 to 10 years, at the present pace, medical center links will exist. All planning should consider classroom television and linkages with commercial and educational television. Problems of color compatibility prevent many institutes from buying equipment now, because it may become prematurely obsolete. It seems likely, from the evolution of surgical teaching at Kansas, that the faculty will discover many of the opportunities and limitations of medical television.

It is important to explore the demands of the television camera. The merits of building libraries of motion picture shorts for teaching via television should be evaluated. The economics of television can be surveyed at Kansas to compare medical student teaching costs against improved teaching, greater coverage, and greater motivation. Doctor subscriptions for postgraduate courses using television can be studied. All interested medical schools should consult the University of Kansas Medical School publications and should not hesitate to visit the site.

The University of Chicago has undertaken surgical teaching using color television. A joint televised project will be sponsored by the American Cancer Society and one of the major broadcasting networks to bring progress reports of latest cancer research to physicians. Exploration of color kinescopy is expected. Fourteen medical schools have indicated active roles in broadcasting public health programs. The Joint Committee for Educational Television has been organized to channel the efforts of many educational forces. It is urgent for medical schools to support educational TV channel applications. Each school certainly will be linked up eventually with an affiliated educational channel.

10.18 Ruhe, D.S., McGrew, W.M., and Klein, M.R. "The Department of Audiovisual Education at the Kansas University Medical Center," Audiovisual News, Vo. 31, No. 11, November 1956.

The appearance of departments of visual education in medical teaching centers indicates the need for better communication in medicine. These departments are service units organized to aid the faculty at reasonable cost and to increase the quality of communication. They work toward educating everyone engaged in medical instruction in utilization of audiovisual facilities.

In this medical center an experimental multipurpose classroom is being constructed with basic fixed equipment: slide projectors; 16mm sound motion-picture projector, screen and blackboard; viewboxes and necessary light control; microphones for public address or recording; ultraviolet lights with fluorescent chalk; cork boards; audio systems; and in three auditoriums, air-conditioning. Equipment is cheap compared to the alternative time waste of students and teachers, with lower-impact learning. Fixed equipment is infinitely cheaper than "mobile" equipment with its constant assembling and disassembling. The equipment at Kansas is not locked up against theft because any obstruction to easy use causes complications. Particular departments tend to utilize small, specially equipped classrooms for their specific needs, which are usually showplaces where teaching with multiple audiovisual tools is taken for granted. Students bring easy proficiency to the use of slides, films, recording, and microphones, and the Center trains and pays six volunteer student projectionists. Formal scheduling is needed only for out-of-class work. These students also form a corps of technicians for other school chores. The entire faculty is also trained in projection, for emergencies.

Although medical teachers know that a volume of audiovisual literature material exists, there is no centrally available, comprehensive index or reference. The situation could be aided by helpful pharmaceutical representatives, faculty members who attend specialty meetings, and specialists' careful culling of the audiovisual journals. There is great advantage to a visible, central film library where teaching groups and students can see available material and create a desire for their use. Standard 2-by-2 slides are cheaper, less fragile, and have brilliant projection at any distance with new projectors. Blower noise is a problem. Motion picture medical presentation is still quite demanding in equipment, film, processing, sound, animation, and economic considerations. Every serious teacher should, however, be making and assembling his own teaching collection to join his slides. Phenomena and methods involving motion belong on film. A reflex motion picture camera is a great help, as are a range of lenses, especially those permitting closeups. But the technical demands of making good films without excess loss of time and money are still unsolved. The task of producing appropriate graphic art is again time-consuming, demanding, and in need of skilled professional help.

Television adds immediacy and reality to medical teaching. Endoscopy by television has a particularly exciting prospect. The large-screen color projector may well become a permanent fixture of all large classrooms. Scrambled-image medical telecasts will be one selective method to bring doctors certain types of material. Research will be aided by new instruments, which also should give radiology enormous new impetus. For public health services, kinescopes for the general public are worthwhile.

10.19 Ruhe, D.S., and Proud, G.O. "Television: Potentialities and Problems in its Use as a Teaching Medium," Transactions of the American Academy of Ophthalmology and Otolaryngology, May-June 1959.

Television relieves teacher shortages and time limits caused by extensive research, education, and medical care responsibilities. Television's vision is ordinary, extraordinary or expanded, modified, and frozen. The most simple method of initiation is installation of ordinary black-and-white television cameras, and the authors recommend the simple, durable, and inexpensive vidicon-tube camera. Specific medical uses do not usually need a studio, but may need two of the camera's powers -- position and magnification through closeups, which is accomplished through lenses. Multiplication of the audience is another gain. Extraordinary vision means that the camera can be applied to optical or electronic systems that amplify sight and utilize visible light, such as microscopes, endoscopes, telescopes, and fluoroscopes. Modified vision indicates ultraviolet, infrared, or X-ray tubes sensitive to limited segments of the electromagnetic spectrum, other than the visible band. Frozen vision is the process of kinescope recording, or making still photographs from the TV screen.

At Kansas it is believed that medical TV begins with a TV camera that a medical teacher can use wherever needed. The Medical Center proposes to develop television as the instrument of the doctor, research worker, and teacher, rather than of the electronics worker. The buildings there are scattered, but the cameras are trucked everywhere within them, rather than being held in fixed studios. Sometimes pictures have to be piped. Studios are sometimes valid for centers that have developed sufficiently and for such uses as postgraduate and lay TV programs. The typical non-studio approach at Kansas includes a 25-seat surgical gallery-classroom that augments the real experience of observing surgical procedures, and does not substitute for it. Lighting is used to try to keep the students' eyes focused on the operating table below. The surgeon below talks directly to his audience and to the collaborating surgeon above. The cameras are taken also to the delivery room. Psychiatry is a good beginning place for TV in a medical center. Color TV applied to microscopy is good, but not good enough to use extensively.

Surgical approaches to the middle ear, nasal interior, and endolarynx do not lend themselves to teaching, as individual maneuvers are not observable and only the end result may be seen. Other specialists also are denied a total view of otolaryngology. An answer to the problem might lie in television endoscopy employing a camera, coupled with a system of mirror light reflexes. The new development of fiber optics might contribute brilliantly. One operator might demonstrate the morbid anatomy while other interested parties watch a screen and listen to an account. A system of living TV has potential worth in eliminating monovisibility from surgical procedures. In fluoroscopy, if new methods succeed, daylight viewing and lowered dosages would be probable. Television has achieved specialization in the form of a tube sensitive to roentgen rays instead of light. Less X-ray dosage is required. Ultraviolet TV and infrared TV are, and continue to be, very promising. Much is to be hoped for television as applied to diagnostic services, research, and teaching.

10.20 Ruhe, D.S. "Eyes for Mankind," NAEB Journal, December 1958.

We are in the process of learning how to project our visions. Talking can be our enemy if we are unwilling to undertake new visual competencies. Those who have succeeded through verbal proficiency find it hard to believe that words are nonspecific and arbitrary, nor do we really believe as yet in the specificity of pictures. But we are shifting from verbal to visual dominance and the cultural implosion will be tremendous.

Human beings perceive phenomena by hearing, taste, smell, pain, cold, heat, balance, and position sense, but we are predominantly seeing creatures. A high proportion of humans think primarily in pictures, and it is an important measure of their brain power. Pictorial impressions flow into our brains daily and mingle with other sense data, altered and shaped by what has been called the psychological filter. Apparently, language functions in part as the systemic structuring of these memories. A myriad of multisensory, psychically-colored images are available in the brain, and recent operations that presented the opportunity to stimulate directly the exposed brain of a fully conscious girl with electrodes recalled complete pictures to her mind from early childhood. This suggests that every visual image of sufficient original input intensity is somehow stored in a facilitating brain pattern which can be evoked by the right internal or external stimulus. Unfortunately, we cannot project these images at this time, but we anticipate a time when we will learn and recall through pictures.

The powers of television can be considered as comprising four categories of sight: (1) ordinary vision -- supplementing the human retina to provide optimal position, magnification, multiplication of audience, and privacy; (2) extraordinatry vision -- gathering or transporting light through microscopes, fluoroscopes, endoscopes, or telescopes; (3) frozen vision -- recording images for future use on tape or kinescope; (4) modified vision -- using special pickup tubes to make visible ultraviolet, infrared, and X-ray pictures.

10.21 Ruhe, D.S. "Medical Education and Television 1960," Research Film, Vol. 4, No. 1, 1961.

In the professional college of medicine the obligation for medical services, in addition to teaching, is so demanding that it usurps time and energy from investigation and/or teaching. Although the faculties are devoted to their work, they are highly overburdened by postgraduate and allied programs.

Diagnostic radiology with television has many present and future advantages. Already, reduced radiation, daylight viewing, easy recording on film or videotape, and easy delivery of images to any number of students, mark its gainful use in fluoroscopy. Ultimately, the TVX camera tube (a television tube sensitive in the X-ray range) will become the office diagnostic instrument of every doctor. Television cameras will expand all routine endoscopy. A working television endoscope for otolaryngology and a "dental probe" have been developed. A working gastroscope and a fiber-bundle cystoscope have been demonstrated. In psychiatry and the behavioral sciences, television allows observation and study of patient and psychiatrist during interviews. Hospital and outpatient surveillance is a useful adjunct, as are hearing and speech therapy, rehabilitation, parent and patient counseling, and teaching psychology. In laboratory and clinical demonstrations, television is used extensively in many centers throughout the country. Color seems to be in demand psychologically, even though monochrome is clear and much easier to produce and control. In surgery, television is revivifying the amphitheater. Laboratory demonstrations in physiology have proven effective. The "visual magnifier" applied to procedural dentistry allows a unique method for students to be at the operator's fingertips inside the mouth, and dental schools everywhere have hastened to employ television. TV microscopy has already prospered, and breakthroughs in TV technology will bring television microscopy into its own. Postgraduate medical education, both on and off campus, will be more feasible through sharing of programs and videotapes.

10.22 Ruhe, D.S., and Gentry, K.C. "Television in Medicine -- Ten Years of Television at the University of Kansas Medical Center," The Journal of the Kansas Medical Society, March 1961.

From 1949 to 1953 the lone color-camera at Kansas University Medical Center was used primarily for procedural surgery, with excursions into surgical anatomy, physiology, and pathology. From 1956, it was applied to undergraduate, graduate, and postgraduate work, and its use in research, teaching, medical care, and lay education was conceived. Improved devices now point to improved personal handling of the visual media. Kansas seeks to make television the means by which the individual teacher can communicate his ideas, regardless of peripheral ideas about television.

The field-sequential color system, despite its good qualities, demonstrated intrinsic shortcomings, and a 3-vidicon color camera was acquired, while solutions were sought for light, mobility, and facility obstacles. The old ceiling installation was removed, and the 3-vidicon camera swung from a heavy dolly-boom designed by the Center itself to be used throughout the Center. The light ring partly remedied the need for large-volume, intense, cool, lens-centered focusable light. Despite gains, color television still awaits improvements.

Monochrome television is far superior technically and economically in radiology. Electronic amplification eliminates dark adaptation, control of picture contrast is easy and automatic, and image storage allows a single X-ray exposure to be viewed over a relatively long period, with attendant radiation reduction. Development of X-ray-sensitive camera tubes theoretically permits a marked radiation reduction for a good picture, and improvements are still underway. Infinite numbers of students, and the radiologist himself, can view routine fluoroscopes from a distance. The image may be recorded on tape or film. Work has been done at Kansas in diagnostic services in relation to cardiac work, speech research, and other areas with motion pictures and television.

In psychiatry, the intimate doctor-patient relationship can be observed without "psychic contamination." Television has been explored methodically for 4 years at all levels in relation to psychiatry. It is particularly usable for outpatient teaching and case supervision, clinical testing of knowledge and skills, studying recorded interviews, conferences, and development of a visual teaching library. Many other behavioral situations have been explored and suggest an endless potential for the television camera.

In endoscopy, television experiments include working with fiber-glass bundles to provide extreme flexibility of endoscopes. A "dental probe," a fiberscope with developed optical accessories, is suitable for preliminary television efforts. Fiber bundles allow exploration of television applications for ear, nose, and throat, and gastrointestinal tract. The University of Kansas has been the leader in proposing and maintaining postgraduate education, and television has been tested here, accordingly. The cooperative inter-hospital linkage tried in 1953 was discontinued in 1955, as long strides seem necessary before such linkage can be economically and educationally effective.

Television in the laboratory sciences seems promising and will be explored here. Television for research instrumentation offers many challenging avenues: TV tubes can be used to solve problems of light, contrast, and time. Other uses of television apply to nursing education, rehabilitation and physical medicine, practical nursing, medical technology, and radiological technology. Anticipating the coming ETV network, Kansas University has equipped and staffed a teaching and productional television unit. The Medical Center has already been involved in lay education, having presented a series of public health telecasts.

10.23 Ruhe, D.S. "Television in the Medical Center: New Eyes for the Medical Profession," World Medical Journal, March 1962.

A camera tube is like an electronic retina -- sensitive to energy from the "visible" portion of the electromagnetic spectrum. Such TV tubes also function where retinal cells fail.

Television plays an extremely significant role in medical practice and in the medical center with its basic and complex aspects of hospital, school, and research center. Television has been applied extensively to the lecture-demonstration, laboratory, and clinic. It magnifies so that a student can follow the surgeon's incisions closely; amplifies light by special tubes; and multiplies images to accommodate an audience of any size, in nearby or remote locations. The television system provides a method of locking and storing images. Contrast amplification enhances human vision, and monocularity of observation can be broken through simultaneous sharing of endoscopic and microscopic images between instructor and students. Students can observe a psychologically "uncontaminated" doctor-patient situation. Selected viewing often allows the learner an experience more intense and "real" than that involving direct personal encounter. The addition of television might possibly revive the amphitheater. Many medical center physiologists and pharmacologists have begun to use television to extend the preclinical demonstration method. Diagnostic radiology has been transformed by cine and television fluoroscopy, with a major breakthrough pending in office radiological diagnosis. Endoscope diagnosis already portends extensive TV applications with its important advance of quartz-rod illumination. In dentistry, some 25 schools now use television in teaching. Care of patients is improved through new diagnostic powers. "Vigilant vidicons" to monitor wards and rooms, which extend the powers of limited nursing staffs, also provide stimulus and escape from pain and boredom of the sickroom. In medical administration, television is an excellent public relations device, and the medical center's responsibility for health education can be supported by effective broadcast television.

Television as an extension of the medical faculty's powers serves many types of students and services. Four years of medical school these days teaches only basic knowledge, and a lifetime of learning follows. This endless process will soon be the obligation of every medical school, as it already has become at Kansas University. The burden and responsibility can be mitigated by planned, national, and international sharing. Television methods for a national arterial system might include a medical television network, videotape-sharing and self-tutorial use of videotapes and their derivative motion pictures.

Basic television equipment includes a black-and-white vidicon-tube camera of good quality (at least 600-line resolution) at about $1,400; a receiver-monitor for about $300; a zoom lens at about $300 to $600; lights, about $100; some form of camera carrier (tripod, dolly-boom, stand), $100 to $500, and 21-inch or 24-inch receivers for students at $250 each. Such equipment is rugged, easy to handle, and long-lived. Replacement of vidicon tubes costs about $220, but is infrequent. Maintenance is handled by trained electronic technicians. Good microphones, speakers, and audio mixers should cost about $200. The total investment mounts when cameras, mixers, and cables begin to multiply. Color TV is excellent but tends to cost $30,000 and up. Cost accounting is based on student hours. If less faculty time is needed to serve vastly more students, then costs may be amortized rapidly. Taxes and fees for equipment and teaching services may quickly be justified.

10.24 Schumacher, H.J., Jr. "A Producer's View of Medical Television," University of Michigan Medical Bulletin, Vol. 27, No. 6, November-December 1961.

Since 1958 the Medical School of the University of Michigan and the Television Center have worked together to produce many outstanding and award-winning medical programs. This successful collaboration led to the planning and use of television for medical teaching at the University. The planners agreed that only color television would adequately meet medical teaching needs. The highest-quality equipment was purchased -- a choice that gave technical and professional staff alike performance reliability, easy maintenance and operation, and, unlike the experiences of sister institutions, presentations unmarred by breakdowns. There are some disadvantages, such as the need for the director to have more technical proficiency, the camera operator to maneuver much bulkier equipment, and the physician to work under much brighter lights, and there is the additional drawback that televising large areas of white causes electronic disturbances. The teaching effectiveness of color television has proven so far superior, however, that these disadvantages were felt to be minimal.

Rehearsal time was a problem to busy teaching physicians, who could not devote the careful hours of preparation heretofore expended on polished performances for the public. Yet, clear, precise visual and aural presentations had to be maintained. A simplified procedure was established whereby the professor requested a presentation from the coordinator and then conferred by telephone with the director about his needs. An hour before the presentation, the lecturer checked for accuracy and organization and then rehearsed on a simple scale. Many faculty members, however, have subsequently requested more elaborate programs and longer rehearsals.

The budget problem of operating-expenses was again solved by close cooperation between the University and the Center. While many other medical institutions in this situation were finding themselves with a lack of trained personnel to operate the equipment and instruct the staff on its maximum potential, the University of Michigan worked out an arrangement with the Television Center. Through careful scheduling, the Medical School was able to draw on a pool of about 60 highly skilled television specialists. Both organizations were enriched by the experience, and the total Medical School budget for TV for 1960-61 was the equivalent of just three nurses' salaries. As the Medical School Television Unit begins its 4th year, the personnel at the Television Center expect an increasing role in the medical teaching program.

10.25 Spaulding, S. "The Title VII Program and Its Applications to Television in the Health-Science Professions." Presentation to Meeting of the Council on Medical Television, April 1961.

Title VII of the National Defense Education Act established new educational media programs. It provides grants or contracts to conduct, assist, and foster research and experimentation in the use of motion pictures, videotapes, audiovisual aids, filmstrips, slides, recordings, radio and television, and related communication media in education; and it authorizes dissemination of information on the new educational media.

Title VII research studies indicated there are certain principles of good teaching that apply, no matter what the medium, audience, attitude to be developed, or whether the concept is in the sciences or arts. These are common denominator problems, although some problems are peculiar to a particular subject area and require research. It is rapidly becoming evident that television, films, videotapes, and of course, still-projected images and recordings can be substituted for actual observation, and that these experiences can teach. Some 42 approved research projects investigate whether new media techniques are as good as, or better than, traditional teaching methods; 46 projects generally investigate their application to specific subject fields; some 38 explore improvement in new media procedures; and some 13 raise basic questions about communication processes and research methodology. These studies should establish basic data on the value of media in teaching, and more studies will be undertaken.

Many studies are rejected by the advisory committee because they do not demonstrate a thorough theoretical orientation; or they deal with the gross comparative effect question, which is one of the common denominator problem studies; or they indicate unawareness of previous research in the area. In framing a Title VII research proposal, one must ask an important question not already answered, which moves the solution of basic problems a step forward. Problems significant only to the researching institution are difficult to finance with Federal funds. Consultation with the Research Section and printed information from the Educational Media Branch are available upon request. Information about research projects should be solicited from the principal project investigator, but final reports will be deposited in 57 libraries participating in the Documents Expediting Service of the Library of Congress and will be available from University Microfilms, in Ann Arbor, Mich. The Department of Audio-Visual Instruction of the National Education Association will abstract all final reports and publish them in Audio-Visual Communication Review. Other basic sources of work done with common denominator problems are Psychological Abstracts, Encyclopedia of Educational Research, Inventory of Educational Television Research, and Teaching with Films.

The future of research in this field will include more specific identification of behavioral tasks to be achieved, and careful testing of such approaches; research on self-instruction -- perhaps in teaching-machine fashion; and emphasis on team approaches of teaching personnel and technology. The objectives of the dissemination program include providing information on educational media research completed, in process, and projected; significant educational media programs and practices; bibliographic data and direct accessibility. The program also seeks to improve educational use and training of professionals for educational use of the new media and to develop national goals, standards, and guidelines for improved use of the new media. Surveys and studies are being made toward publications for a Title VII bookshelf. Understanding the role of media in education includes understanding the process, theory, and practice of education; the role of various media in combination and isolation; programing techniques; requirements of administration and organization; research; and curricula.

10.26 Towsley, H.A. "Closed Circuit Television in Modern Medical Education: The Goals of Medical TV," University of Michigan Medical Bulletin, Vol. 27, No. 6, November-December 1961.

Television used as a visual aid for teaching overcomes the difficulty of reaching large groups and allows students to view meticulous detail with unprecedented clarity. It is not intended to replace student laboratory work, or student-teacher and/or patient communication, but rather to provide complementary visual aid for further enlightenment. Color television is an additional asset in that it permits the student to observe color changes of the human body in health and disease, and in relation to such varying aspects as the operating table, laboratory, and microscopic studies.

The University of Michigan faculty feel their experience has been unique in using closed-circuit color television for undergraduate and intramural postgraduate medical education. They attribute their success not only to an already existing campus television installation, but to faculty, staff, administration, and participating foundations, all of whom combined, each with its own specialty, to provide leadership, know-how, funds, and enthusiasm.

Future plans include transmission to participating hospitals of lectures, demonstrations, and clinical conferences for both undergraduate and continuing medical education. A videotape library will be accumulated for appropriate use in undergraduate courses.

10.27 Wachenbach, D.E. "TV Holds Hospital in Educational Focus," Hospitals, the journal of the American Hospital Association, Vol. 34, August 1960.

Through an endowment fund to Butterworth Hospital, Grand Rapids, Mich., it has been possible to present lectures by nationally recognized medical authorities. The popularity of these lectures drew physician attendance beyond the capacity of the auditorium. Closed-circuit television solved the problem. The hospital's administrators did not want to add to the cost of the patients' bills, or to its own operational costs, and accordingly, joined forces with a local television station and two local pharmacies to aid financing. This was also a public relations and a program-planning achievement. The usual cost of a commercial closed-circuit telecast with a city or single building is from $2,000 to $5,000 for an hour's program.

All those attending the lecture eat in the hospital's television-equipped cafeteria and proceed to the auditorium when finished. Those still eating when the lecture begins are able to see and hear the program clearly, since the sound is loud enough to overcome distractions. The speaker moves to the dining room for a question-and-answer period after the lecture, allowing the auditorium audience to witness the program and allowing the diners to see the speaker in person. Because of each speaker's prominence, the lecture is an important event in the community and receives press and radio publicity. The entire program allows hundreds of physicians to see and hear great medical personalities from all over the United States and even overseas, and also brings together a physician audience who meet and share information, knowledge, and experience, and who might otherwise never have done so. The hospital believes these programs increase physicians' awareness of hospital facilities, and stress continuing medical education.

10.28 Warren, F. "TV in Medical Education," American Medical Association, Chicago, 1955.

This handbook provides a pictorial introduction to television for the medical practitioner and educator. It is supplemented with captions and an extremely brief narrative text dealing with the concept of television, how it works, and the parts and accessories involved, as well as their functions.

The second part relates specifically to medical productions on television; the function of the script, placement and use of microphones, and aids to the person appearing on the television to heighten his presentation. The "do's and dont's" with regard to clothing and appearance, various prompting aids and devices, and a glossary of hand signals are provided.

The final section deals with means of transmission, such as open-circuit, closed-circuit, and scrambled images, and the application of techniques. Standards for reception areas are suggested, as well as a list of subjects that have been presented effectively on television to date. A chronology of firsts in medical television provides an indication of the development of the medium. The booklet concludes with a glossary of television terms. Three or four diagrams or illustrations on each page provide a quick visual reference of the basics of television for the layman.

10.29 Wollnough, J. "Television in the Teaching Hospital," World Medical Electronics, Vol. 1, No. 2, September 1962.

The television system in the new building of the Liverpool Royal Infirmary is probably the most comprehensive in Europe. The entire project was researched beforehand for best possible teaching facilities and implemented by a senior member of the surgical staff. Color television was rejected because of high cost, but more particularly, because of the difficulty of maintaining high picture quality under frequently changing movements. Good monochrome was found to be almost as good as good color and better than bad color.

The installation covers four operating theaters, a lecture theater, X-ray room, students' common room, and a small examination room, with provision for future extension to other areas. Two theaters (without viewing galleries) are equipped with a camera set into the scialytic lamp, in addition to a mobile camera mounted on a boom which, with its monitor, can be used in either theater. The two theaters having viewing galleries are similarly equipped.

The picture monitors show the broad technique, and through automatic lens changes, enable students to observe magnified details. Each theater is linked to viewing areas by 2-way audio. Students ask questions that the surgeon can answer by reference to his monitor picture. The link from theater to X-ray room will facilitate consultation between surgeon and radiologist during the operation with reference to the televised picture. Fan-shaped seating in the lecture theater gives each student an unrestricted view of the monitor. The future link with the patient examination room will permit 100 students to watch patient examinations without embarrassment or time loss. Preclinical students will view operations from the students' common room, augmenting and illustrating their anatomical and physiological studies with this graphic reinforcement of the value of such preclinical work.

In this new building, no onlookers will be permitted in surgical areas and all surgical and television equipment will be kept permanently within the theaters to avoid contamination and possible postoperative infection of patients. Liverpool Royal Infirmary, by designing a building with television in mind, sets a standard too high for most old teaching-hospitals, but a great deal can be done even in the oldest buildings. One technician runs the control room and maintains the equipment.

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